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Research Article

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Earth Architecture in Rural Egypt: Changes in the Context and the Material


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Abstract: *The rural villages in Egypt have a long history and tradition for earth architecture. However, these villages have undergone many changes, which resulted in the gradual disappearing of earth architecture. Instead, contemporary building materials are taking over the building industry. This has led to many environmental, economic and social problems. Earth, on the other hand, is a natural material, which has a very low impact on the environment, when compared to concrete and red brick. After many years of innovations and technologies in the field of earth construction, the material was developed technically, structurally and also, esthetically to withstand the current building challenges. The study aims to identify the challenges for creating middle density rural villages in Egypt using earth as a building material and analyze the significance of these challenges nowadays. The methodology literature review using case studies of the Egyptian rural context changes from the past to the present and how these changes resulted in the disappearance of its traditional earth architecture.*

Keywords: *Rural housing, population growth, vertical extension, earth construction techniques, Egypt.*

Mısır'da Dünya Mimarisi: Bağlamın ve Materyalin Zorlukları

Öz: *Mısır'daki kırsal köyler, dünya mimarisi için uzun bir tarihe ve geleneğe sahiptir. Ancak, bu köyler, toprak mimarisinin kademeli olarak ortadan kalkmasıyla sonuçlanan birçok değişikliğe uğramıştır. Buna karşılık, çağdaş yapı malzemeleri de yapı endüstrisini ele geçirmektedir. Bu durum birçok çevresel, ekonomik ve sosyal sorunlara yol açmıştır. Toprak, beton ve kırmızı tuğla ile karşılaştırıldığında çevreye etkisi çok düşük olan doğal bir malzemedir. Toprak inşaatı alanında uzun yıllar süren yenilikler ve teknolojilerden sonra malzeme, mevcut bina zorluklarına dayanacak şekilde teknik ve yapısal olarak geliştirildi. Çalışma, yapı malzemesi olarak toprağı kullanarak Mısır›da orta yoğunluklu kırsal köyler yaratmanın zorluklarını belirlemeyi amaçlıyor. Beklenen sonuç, Mısır›ın kırsal bağlamında yeniden kullanılması için dünyanın karşılaştığı zorlukların belirlenmesidir.*

Anahtar Kelimeler: *Kırsal konut, nüfus artışı, dikey uzatma, toprak yapım teknikleri, Mısır.*

1. INTRODUCTION

Nowadays people in rural areas of Egypt tend to use concrete and fired brick masonry instead of Earth as building materials. These materials are responsible for not only environmental problems such as carbon emissions, energy crisis and waste accumulations but also, economic problems as these building materials' prices are in a continuous increase. Not to mention that the use of conventional building materials in such a context leads to the loss of its valuable tradition and culture. This has transformed the villages into an informal imitation of the city. On the other hand, earth has many advantages to the environment since it is totally recyclable and also affordable.

This raises the questions, what are the current village needs? Is the earth really unable to fulfill those needs? Are the earthen building materials unable to cope with these changes? What are the barriers that face this material in the rural Egyptian villages?

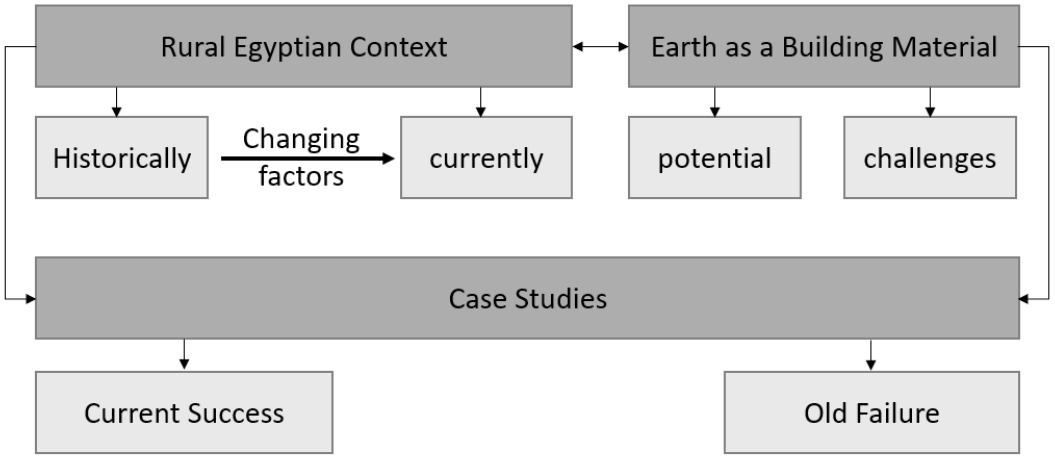

Figure 1. Research Strategy (by author, 2021)

Part 1: Evolution of the rural villages → their current needs and challenges

Part 2: Earthen material properties → potentials and challenges

Part 3: Case studies → reply to the question of the significance of the material challenges nowadays

Part 4: Discussion → findings of the three previous parts discussed.

This paper aims to identify the changes and challenges in the context and the challenges of the earthen material. Moreover, evaluate the significance of these challenges nowadays in hindering the use of this material in this context using two different case studies from two different times in the same location.

2. EGYPTIAN RURAL CONTEXT

This section will make a comparison between the Egyptian rural village historically and currently on an urban and building scale. Moreover, discuss the different factors which have led to these changes in the context. Through this narration, it will be possible to understand the challenges that context has and the barriers, from the context perspective, for the reuse of earth in these villages.

2.1. Historical Village Characteristics

The Egyptian village is the original form of human settlement in Egypt's history. It's the basic unit that adheres to a social system with all its customs, traditions, and institutions that are inherited from ancient times [17]. The Egyptians were the first settlers who cultivated, built and organized social, moral and political life. The present village of the Nile of which there is so much complaint, is the direct heritage of a people who gave the world its oldest civilization [3].

2.1.1. Urban scale

The typical rural villages can be described as a compact settlements surrounded by intensively cultivated fields [7]. For more than 5000 years, the rural Egyptian villages were restricted to the area on a hill to be protected from the Nile flooding. The planning of the rural villages is a reflection of the relation between the village inhabitants. The people are grouped in clans and the planning of the village was the same: the planning suits separate quarters where open spaces are left between each group. These open spaces gave the opportunity for interesting public activities to happen such as market places, play-grounds, or places for mosques and churches.

2.1.2. Building Scale

These villages were characterized by the mud family house. This house was a social catalyst which was built by the family and relatives and extends by adding more units to accommodate new family members. The housing unit for the peasant is an "organic creation" that aims to fulfill his fundamental needs. This historical and traditional creation is directly connected with the agriculture, cattle and the growing society in the rural Egyptian villages. The house was based on the grid of around 3x4 square meters and connected within an alley from two to three sides to other houses.

The social and economic class of the family affects the size of the house. There is a minimum of three particular classifications that represent the economic status of the rural village inhabitants. These are as follows:

- The well-to-do peasant
- The middle peasant and
- The laborer or very poor peasant [3].

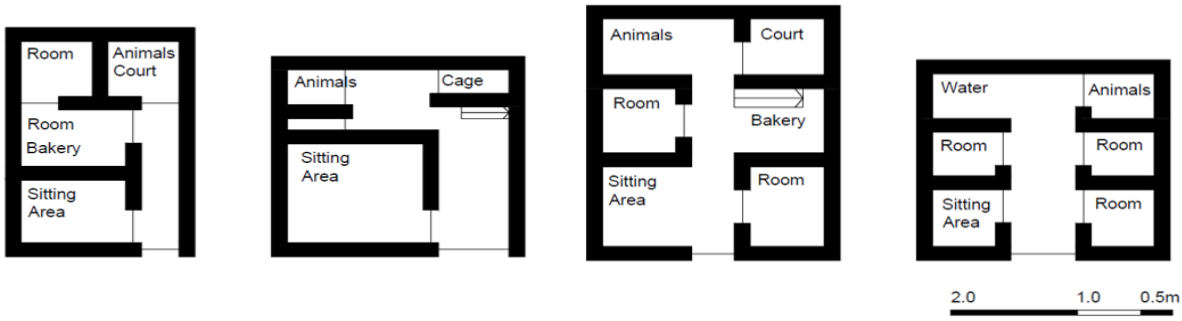

Figure 2. Typical medium rural housing typology (Redrawn by Author from sketches by Dr. Fathy M. Muselhi, Between the Problems of Comprehensive Development and Village Planning: Urban Egypt at the beginning of the 21 Century (Dar El Maarif Al Gamia. Alexandria, 1990)

The smallest house was consisting of one room for sleeping and also for receiving guests. At the end of the house, the animals' cage can be found (Figure 2). The roof was used for storing corn (maize) and cotton stalks, as well as dung cakes which are used for fuel. Roofs were also favorite sleeping places in hot summer nights. The middle-class house had an additional multi-purpose zone while the rich house was bigger and had a more prominent location.

(1) First rate dwellings for rich and leading groups 10 %
(2) Middle class dwelling 20 %
(3) Ordinary dwelling consisting of one, two, or three rooms 70 %.

Most of the rural housing units were built using the local building materials. Those local building materials are widely available and they just need good observation for the resources available on site.

The mud brick was one of the most used building materials which was available excessively along the Nile (Nile sedimentation), also, from excess mud from the agricultural land (later became permitted by law) or the cleaning up of water canals. Along many years the villagers have gained valuable experience to know the characteristics of these raw materials and to make full use of them.

Figure 3. Peasant making sundried clay bricks (Borchardt, 1929)

The peasant had to make the mud brick house himself and he only request the help of a mason for the construction of the walls. All the rest of the building process such as plastering, roofing, or flooring was done by himself, his family, and some relatives and friends. The villagers used to assist each other when constructing a house and every member had a specific role to do such as that the women were responsible for plastering the walls from outside and inside. Participation was perfectly applied in the community. This can be analyzed through many perspectives; however, it is clear that the construction material is one reason for that. Suitable building materials and techniques of construction have to be chosen for a successful community participation in rural housing. The adequate building technology facilitates and eases community participation [19]. Moreover, more sophisticated and higher construction technologies progressively decrease the direct involvement of the community members in the building process for some authors [13].

2.2. Reasons for the Change

During the last fifty years, the rural villages have undergone huge transformations. Many aspects have caused these transformations to appear in the rural villages. These transformations can be classified as economic, environmental, and political changes.

2.2.1. Economic

• **Modernization/ Industrialization:** The Egyptian economy started to transform from agriculturally based economy to an industrialized economy. This has opened the door for many new imported building materials to be available in the Egyptian market.

• **Land prices**: In the rural villages of Egypt the annual housing demand has reached 460,000 households according to CAPMAS 2017 report [6]. CAPMAS is the Central Agency for Public Mobilization and Statistics is the official statistical agency of Egypt that collects, processes, analyzes, and disseminates statistical data and conducts the census. Moreover, the land prices are significantly high because all the land plots are suitable for agriculture. In addition, the villages became a place for the affordable housing seekers especially those villages which are close to the cities [17].

• **Peasant immigrations:** A lot of the poor peasants started to immigrate to the Gulf areas to upgrade their living. After returning, they wanted to imitate the "modern" styles and materials in their villages [17]. Besides, many mud houses were abandoned without any maintenance.

2.2.2. Environmental

• **Global warming:** Most of Egypt is a desert and is classified as arid (except for the Mediterranean coast, which is semi-arid). There is evidence that the severity and frequency of flash flooding across Egypt has increased in recent years [21]. Therefore, historically, earthen buildings were not in threat of excessive rain so no proper insulations and proofs were installed, which resulted in many destroyed earth walls in the villages and this led to the "poor image" of Earth.

2.2.3. Political

• **Aswan High Dam Construction:** After 1961, the annual flooding has stopped after the construction of the high dam which freed the villages from staying on top of the hills and allowed horizontal expansions. The less water means less mud for the construction industry.

• **Laws and Regulations:** Law number 154 of 1980, article 150 and 151 on agriculture (Also check Agriculture law issue No. 53 (1966) and an addition of law No. 116 (1983)) prohibit the use of soil from the fertile agricultural land in any act of construction. Also, they prohibit building on agricultural land

2.3. Current Village Changes

The previously mentioned factors have led to major transformations in the rural Egyptian village. They have restricted the availability of the earthen materials and made the "modern" building materials widely accessible. It has not only created a bigger housing demand than before, but also, built a social barrier for earth construction as being an old fashion and poorly imaged.

Table 1. Change in the rural villages with reference to scale

	Reason for change	**Change in the Built-environment**	**Scale**	
			Urban	**Built**
Economic	Modernization	Easier accessibility to "modern" materials		●
	Land prices	Denser housing typology	●	●
	Peasant immigrations	Deterioration of the earthen buildings		●
Environmental	Global warming			●
Political	Aswan High Dam	Lack of availability of earthen material	●	●
	Laws and Regulations		●	●

As the villages grew, the need for formal and informal initiatives grew, as well, to conserve architecture in the Nile Valley from the major threats. Formal initiatives by planners, decision makers and local authorities are producing comprehensive plans for all Egyptian villages. It can already be observed in numerous villages. They are starting to lose their identity and being transformed to informal housing imitating the big cities in Egypt: Reinforced concrete multi-storey buildings with no identity, aesthetic, environmental or functional values [16].

1.2.3. Urban Scale

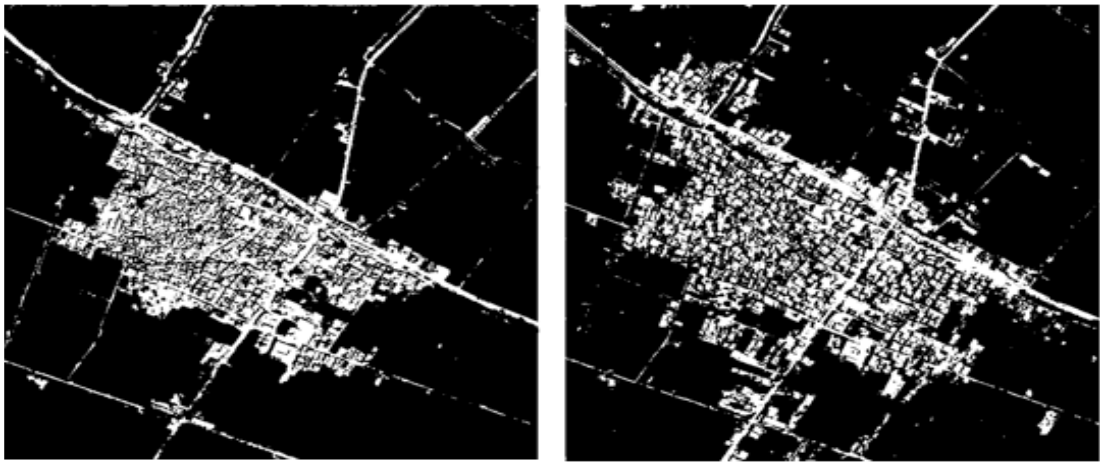

Figure 4. Mit Gaber, Sharqia google earth images of 2005 (left), 2020 (right)

During the 20th century, the villages broke loose from the island village. They started to expand outside the original hill on which the village had stood for eras to decertify agricultural land by constructing more settlements for the dramatically increasing populations. The excess increase in population is a complex issue as the soil which is suitable for farming is limited to a thin strip along the river Nile [16]. Numerous locals divided their houses or added couple of stories to their current houses and offered them for rent. Some destroyed their buildings totally and re-construct them with new modifications that are suitable for renting. This trend resulted in the disappearing of the traditional family house design and the imitation of housing design similar to what is found in the informal housing extensions of the major cities.

2.3.2. Building Scale

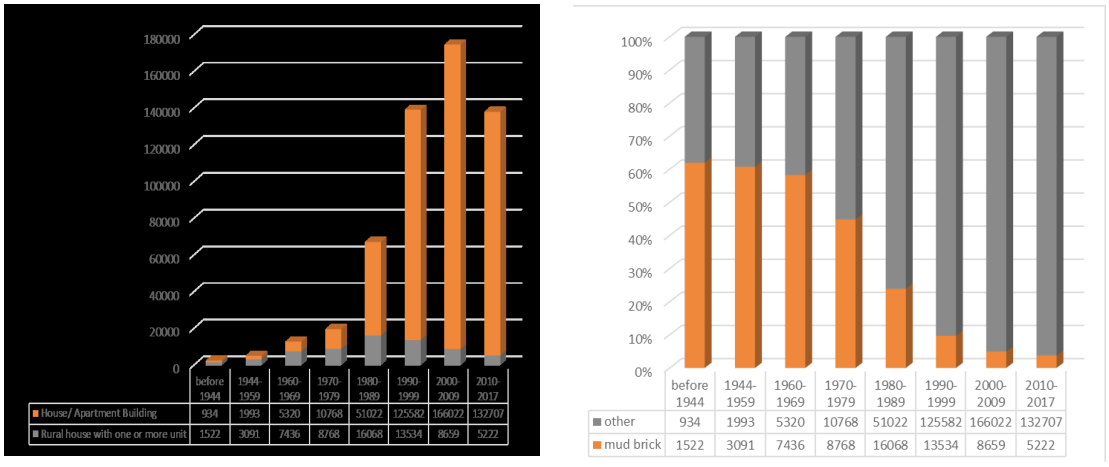

Figure 5. Number of Complete and Fully Occupied Rural Housing Buildings from year 1944 till 2017 by Type of Building and construction method respectively (data by CAPMAS, 2017; by author, 2020)

In the early seventies, most of the family units were single story houses and the rest were two-story houses with extremely few three or more stories high. After the 1973 war, new housing typologies took over the horizontal and vertical extension of rural settlements [17]. In a CAPMAS report of 2007 (latest report) of housing and building, some statistics were issued that reveal some important characteristics of the housing typologies nowadays in the rural villages. In the year of 2000, 50.7% of the households in rural Egypt are the rural house of one or two storey buildings that used to be owned by a family and 28% are Flats [2].

Figure 6. Continuous extension in the villages (by author, 2019)

An obvious observation when visiting those villages is that most of the buildings have untrimmed columns on the roof. This is a real indicator for the real need of expansion and more space for household. The village is in a continuous expansion and construction process. In figure 2, the change of the vertical extension in the village has dramatically increased in only 15 years and this can be seen through the building shadow between the two pictures. In 2016, the Egyptian parliament was discussing modification in the unified construction law 119 for the year 2008. This law is restricting construction in rural areas and making use of the rural expansion to urban. The parliament committee is suggesting the allowance of building the ground floor plus two typical floors whatever the street width is in the villages [21].

Table 2. Comparison between rural villages in Egypt historically and currently.

	Historically	**Currently**
Urban Scale	● grouped in families [17] ● open spaces have social activities ● limited to the island area ● higher crowdedness level ● migration to different village island ● homogenous society [19] ● deep connection to agricultural land [13]	● subdivided and sold/ rented [2] ● new buildings on open spaces ● expand on agricultural land [17] ● vertical extension [21] ● broke loose from the island village [16] ● many outsiders seeking for affordable housing ● non-sense of belonging to agricultural land [17]
Building Scale	● rural family house ● around 12 m2 footprint [3] ●1 to 2 floors ● mud bricks (adobe) [5]	● Apartments [2,6] ● around 12 m2 footprint ● 3 to 5 floors [12] ● concrete and red bricks [9,14]

To sum up, the Egyptian villages that we have today are totally different that have been historically there from an urban and building scales. The historical village was characterized by mud brick family houses however, today it has multi-storey apartment buildings built with concrete skeletons and red brick walls.

These observations indicate that the context has, in a way or another, repelled the earth construction and seemed to have found adequate alternative. What are the qualities that can the earth construction offer to the rural Egyptian villages nowadays? And what are the challenges the material still has? Are these challenges currently significant?

3. EARTH AS A BUILDING MATERIAL

Although earth architecture is rarely produced recently by the locals in the rural villages as is it used to be before, there are actually many potentials for the earth to be revitalized again in the villages. These potentials are ranging from environmental and economical to social benefits. However, there are also challenges that face this material to be capable for meeting the current needs of the context.

3.1. Potentials and Challenges

The material availability in Egypt is a critical issue as being said before that the construction of the high dam and different laws have affected the availability of the material. Clay in Egypt is very important for vegetation and, due to continuous acts of desertification and over use in fired clay bricks; Egypt is losing its agricultural land. As a result, laws were issued permitting the use of Nile sedimentation in construction purposes. However, Egypt was discovered to have another type of clay which is desert clay and, this clay is very suitable for earth construction and does not affect any agriculture. This type is now being used in all new earthen buildings. On the other hand, the earth is nowadays, globally, determined to have the following potentials and challenges:

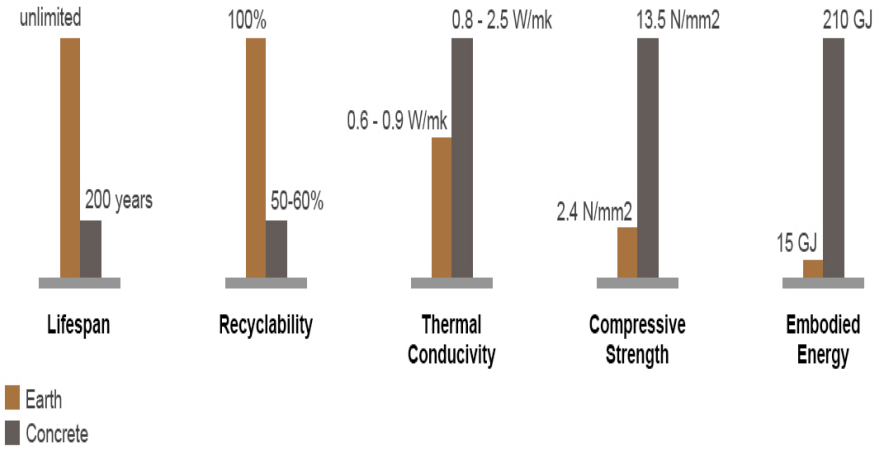

Figure 7. Potentials and challenges of Earth [10]

- **Lifespan (durability):** The meaning of durability when referring to earth is different from that of concrete. Earth is an aging material; this means that year after year, the earth starts to have some wrinkles. This is an important aspect with is inversely perceived by people as non-durable material. In a TED talk in April 2017, Anna Heringer explained that, in her METI School in Rudrapur village, Bangladesh, if a wall has any kind of time deterioration or the edges are not sharp as before, the broken part is taken and made wet and mixed then put back on the wall.

- **Recyclability:** There is no other building material like earth, which is 100% recyclable and environmentally friendly. At the end of life of an earthen building, the building components can be totally recycled with no waste accumulation.

- **Indoor Air Quality (IAQ):** Earth works as humidifier for the building due to its moisture content. It also works as a thermal mass so it works best with hot days and cool nights.

- **Embodied energy:** When compared with concrete and red brick, the earth does not involve any firing

or excessive energy during its production. When produced locally, the earth does not require even transportation and fuel consumption.

• **Compressive strength:** Shibam town's buildings in Yemen are a historical evidence that adobe bricks can bear loads up to 8 storey high and they have been standing for more than 500 years. However, earth building standards still do not permit high rise buildings with several floors and it is accordingly not yet experimented or applied. Despite the fact, earth has many potentials, compressive strength of earth is still a challenge that the material faces when being compared by the other building materials like concrete.

• **Social Perception:** After the modernization and many changes in people's lives and in the building industry, the earth is now perceived as a "poor material". The problem is apparently more related to the perception of the people and the skill of the architects/ designers rather the capability of the material. On the other hand, construction process which not only is simple and does not require skilled labor, but also, promotes user participation and creates sense of belonging.

• **Construction time:** traditional earth construction is a labor-intensive method which requires relatively more time than conventional building methods

• **No standard mixture:** Each soil component is different from one location to the other; therefore, there is no standardized mixture components or ratios during construction. The soil has to undergo testing procedure in order to identify the needed mixture.

Table 3. Potentials and challenges of earthen building materials (by author)

Life Span	Recyclability	IAQ	Embodied Energy	Social Perception	Compressive Strength	Construction time	No standard mixture
Potentials				**Challenges**			

As has been discussed, earth construction has many potentials to be reused in the Egyptian rural villages. Historically, in the Egyptian context, the mud brick is the only used technique for many years. As discussed before, people in the villages have seen the mud brick walls deteriorating which, along with the other reasons, created a social barrier for the earthen use.

Figure 8. Common earth construction techniques (by author, 2021)

According to CRAterre (an Earth UNESCO chair for earthen architecture, which has started in 1979 to revive earth construction material in the building industry using research, education and many projects worldwide) there are more than 12 different earth construction techniques [8]. They are divided into three main sectors in a pie chart: filling in, monolithic and masonry by Houben H, Guillaud H CRATerre 2006 Traité

de construction en terre Éd Parenthèses. Those techniques were historically used and further developed for current projects worldwide like rammed earth, cob, compressed earth blocks (CEB), adobe and many more (Figure 4). However, recent initiatives are starting to introduce these other construction techniques such as: rammed earth and CEB, to the Egyptian market which will be discussed in the case studies if those new construction techniques can contribute to a new revival for the earth construction.

4.CASE STUDIES

The previous sections showed how the context has greatly changed and these changes have created new needs and barriers which doubt the ability of the traditional earth construction method to fulfill those needs. Vertical extension, earthen material availability and social acceptance are among the context needs and the compressive strength is among the earthen materials challenges. The following case studies test the significance of these challenges in reference to different earth construction techniques in the same Egyptian governorate but in two different eras.

4.1. Old Failure: New Gourna Village, Luxor, Egypt

New Gourna village was designed by the Egyptian architect Hassan Fathy. It was partially built between 1945 and 1948, in Luxor. Mud bricks for Hassan Fathy were not only a building material, but also an ideology of interaction between man and his environment.

Figure 9. Hassan Fathi's New Gounra before and after distraction (Aga Khan Trust for Culture and Aga Khan Trust for Culture, respectively)

Unfortunately, in 1948 Fathi's great initiative project New Gourna has witnessed many structural problems. Cracks started to appear on the mud brick (adobe) walls causing many damages to the buildings. Accordingly, the villages left this village and it was never repaired or maintained [1]. The earthen materials, back then, was held responsible for not being durable enough to stand longer. However, the main reason for this damage was the lack of sewage system, which raised groundwater level which resulted in moisture and salt migration, contributing to the disaggregation of limestone within foundations and de-cohesion of mud bricks. In walls, this results in significant erosion, destroying the outer coat of earthen bricks [18].

After some decades from its first attempt to move the residents from Gourna, the Egyptian government repeated the attempt on the same background of protecting Pharaonic monuments. The second version of the New Gourna, known officially as the 'New Al Taref', came totally different from Fathy's New Gourna project. The work in this new village began in 1997 and finished in 2006, while transferring the Gournii to their new homes began on 15 August 2006. In order to force the residents to leave their houses in old Gourna and move to the new site, the government demolished most of these houses [1]. One of the main environmental problems associated with this project is the absence of locality in the whole construction process in contrast to mud brick buildings. The adopted building materials are reinforced concrete and burnt red brick that can be found anywhere in Egypt regardless of their suitability for the specific climatic conditions of the region. In addition, in comparison to the local building materials used in old Gourna, the production of these materials requires much higher level of energy and they are, to a far extent, not recyclable. As an indicator of the irresponsiveness of the used building materials to the harsh climatic conditions, cracks immediately

appeared in some of the new houses, especially between the reinforced concrete beams and columns on the one hand and the red burnt bricks walls on the other hand.

This case study shows that the lack of sewage system and insulation technology have significantly affected the durability of the earthen building causing major structural problems. This has, accordingly, affected the social perception of the material and made it lose its reliability. In this case study, it is, also, clear that "modern" building materials choice is not the solution, where people missed many the potentials of the earthen construction such as: indoor air quality, embodied energy, affordability and even faced structural problems due to the irresponsiveness of the used building materials.

4.2. Recent Success: The Luxor house, Al Rezkyat Bahary, Egypt

Hand Over is a design-build company, which consists of a team of architects, civil engineers, material specialists and builders. They aim to build sustainable buildings using natural building materials to create a social impact and revolutionize the building industry by creating solutions that are environmentally friendly and feasible.

Figure 10. Luxor House roof (Hand Over office, 2019)

Al Rezkyat Bahary is a village is located along the River Nile in Luxor. The village emerged organically between the farmlands overlooking the river. The aim of this project was to design a housing solution in Upper Egypt that would be human-centric, economic and environmentally friendly.

The Luxor House construction started in September 2019. Inspired by the traditional houses and responding to the users' needs, the design team created a shared semiprivate space for the family where they can gather and engage activities. Therefore, a court was designed as a shared central space with a traditional oven included which the family can use for baking. The design included an upper floor to allow the family to expand easily. The upper floor was designed to have one room and a large terrace where the family can gather at night to enjoy a cool breeze. Due to the budget of the project and the time given, the design changed from two floors to only the ground level floor.

Stones were used for the foundation as a strong natural raw material, which is a very reliable material to insulate the earthen walls from being damaged by water. The rammed earth was used for the walls, where humid soil is poured in a wooden formwork in thin portions (10 cm) and then rammed to increase its density and after they were cured, clay plastering was added to give a contemporary appearance to the house.

An important goal in the construction process is knowledge transfer from the master Engineer, to the builders of the project. They would learn to implement challenging forms such as the domes and vaults in the house. The project had a healthy and humane environment on site as the owner and his family was part of the construction process, they shared meals with the workers and helped in small parts of building.

In this case study, the potentials and values of the earth construction can be observed. Rammed earth construction techniques, in this case, is a densified technique where force is applied in each earth layer. This upgrade the compressive strength of the walls and allow the possibility of vertical extension with no

remarkable added wall thickness. Moreover, the well applied insulation technology had a positive impact on the durability of the building. Furthermore, different modern plasters techniques give the building a contemporary look which also promotes the social acceptance of the material.

4. DISCUSSION

After going through the three main focus parts of this paper, which are: the context and the material followed by the case studies, it is crucial to find the interconnections between them to be able to better understand the significance of the material challenges in the current context changes.

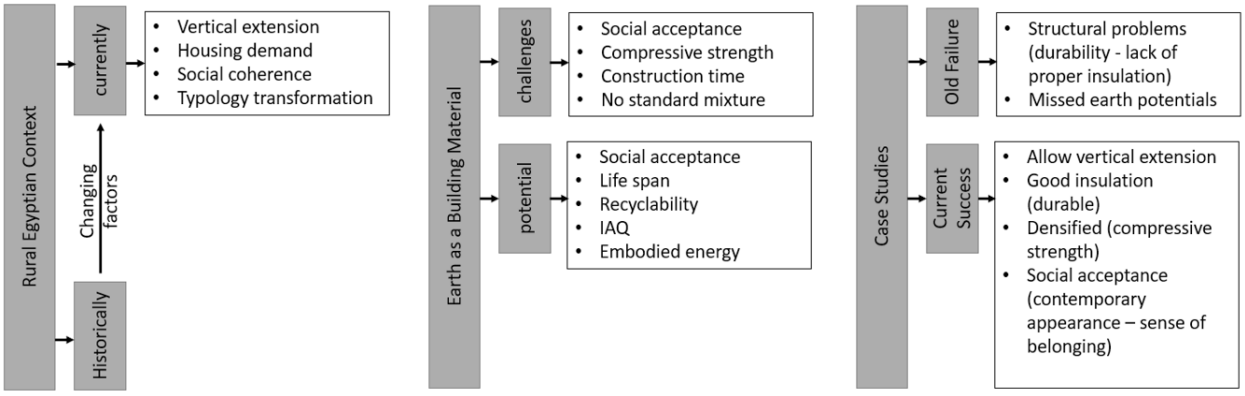

Figure 11. Inter-relations between context and the material challenges (by author, 2021)

As figure 11 shows, the rural Egyptian village is in need for vertical extension due to the dramatically increasing housing demand. Vertical extension requires high compressive strength which is currently possible by using the rammed earth and CEB techniques which are densified techniques that allow multi-storey buildings with no significant wall depth increase. However, the housing demand also needs mass production and relatively quick construction process which is still a challenge for the material. This challenge is now under experimentation after Martin Rauch (Lehm ton Erde) used preproduced rammed earth walls in his AlNatura Headquarters in Darmstadt and Ricola Kräuterzentrum in Laufen.

Moreover, the social barrier is a result of lack of maintenance and poor water insulation as a result of lack sewage system. This can be upgraded through the current insulation technologies in the building foundations which accordingly contribute to the durability and the structural performance of the earthen walls. The social acceptance can also be treated by different modern plasters techniques gives the building a contemporary look which gives a message that earth is no longer an old outdated material.

Further challenges are still available like the wide spectrum of the soil types which makes the building process not standard and requires sufficient experience. However, the villagers are believed to have a great tradition with the earthen material which needs to be revived and rescued from being disappeared.

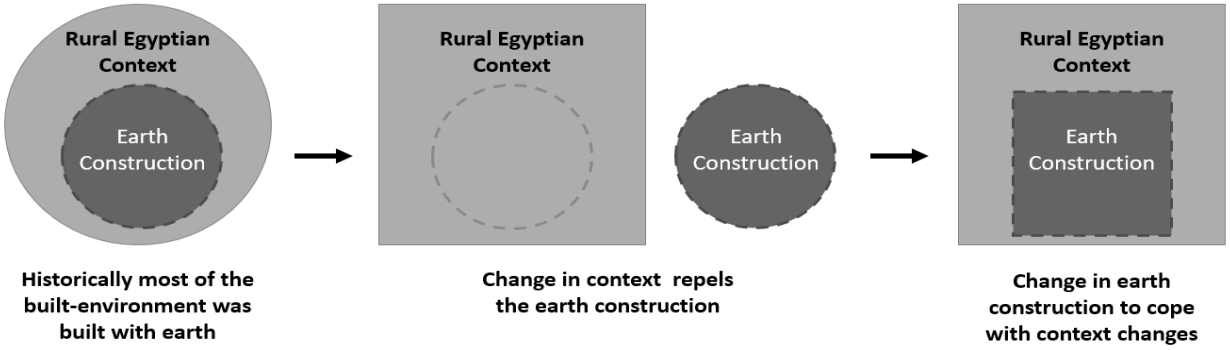

Figure 12. Earth architecture has to change as the context change (by author, 2021)

In the case study, an important conclusion in that "modern" building materials choice is not the solution, where people missed many of the potentials of the earthen construction such as: indoor air quality, embodied energy, affordability and even faced structural problems due to the irresponsiveness of the used building materials. Earth construction, also, contributes to the homogeneity of the society during the building process which we currently miss at the rural Egyptian villages. However, the traditional earth construction technique is also not the solution (see Figure 8). The earth construction requires a contemporary upgrade to contribute to the material acceptance and the villager's needs.

5. CONCLUSION

The rural villages in Egypt have a long tradition with earth architecture. However, this material is starting to be replaced by the conventional building materials which have a huge negative impact on the environment, economy and society. The villages have huge need for expansion due to high rates of population growth. The horizontal expansion is not a valid option to be able to preserve as much of the precious agricultural lands as possible.

Earth, in return, has huge environmental potentials such as very low embodied energy, recyclability, no waste accumulation and high thermal performance. The only earth construction technique that was tried in Egypt was the mud brick (adobe). This is a very ancient technique, however, there are other techniques that have shown potential to be used in the rural Egyptian context such as rammed earth, CEB and cob. These techniques are proving to upgrade the earthen materials as it has a better compressive strength and durability than the adobe.

It is crucial to test the different earth construction techniques using different desert clay soils from Egypt to know if the compressive strength of earth can allow medium density housing (three or more floors) in the rural villages. Moreover, to investigate the impact of using different earth construction techniques on the structural thicknesses, effective floor area, thermal behavior, energy savings and economic savings. Moreover, the initial building costs, embodied energy, life cycle analysis and carbon emissions have to be taken into account as well. All of this has to be compared with the conventional building materials to be able to have thoughtful recommendations for alternative building materials and techniques for the rural Egyptian villages.

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The Evaluation of the Effect of Mass Housing Facades on Comfort Conditions: The Example of Ataköy



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Abstract: *Houses are spaces in which occupants spend long hours and expect to have the comfort conditions (thermal, visual, acoustic). A large portion of increasing energy consumption as a result of technological developments and industrialization is for heating and cooling residential buildings and residential buildings are increasingly located more in areas that are exposed to high external noise levels which all increase the level of importance for facades to provide thermal and acoustic comfort conditions. Ataköy region is an example of a residential area that shows the effects of developments in our country with changes in architectural approaches and construction technologies since its establishment. The objective of this study is to assess facade performances of public housing buildings which were built with different facade characteristics in different periods in Ataköy for thermal and acoustic comfort and energy consumption. To do this, the efficiency of the facade systems of the residential buildings which were built with different materials and facade systems and similar block layout in the 1950s and 1980s in a neighbourhood with high traffic noise in Ataköy was assessed. Heating and cooling energy loads and thermal performance evaluation of selected buildings were calculated by Design Builder simulation program and noise reduction values of facades were calculated by the KS program. The comparative results of the changes in thermal and acoustic comfort and energy consumption in the buildings constructed by using brick and concrete facade panels were assessed using charts.*

Keywords: *Building envelope, noise control, energy efficiency.*

Toplu Konut Cephelerinin Konfor Koşullarına Etkisinin Ataköy Örneği Üzerinden Değerlendirilmesi

Öz: *Konutlar, kullanıcıların içinde uzun zaman geçirdikleri ve konfor koşularının sağlanmasını (termal, görsel, işitsel) bekledikleri alanlardır. Yaşanan teknolojik gelişmeler ve sanayileşme ile artan enerji tüketim miktarlarının büyük bir kısmının konutlardaki ısıtma ve soğutma faaliyetlerinde kullanılması ve hızlı kentleşme ile yüksek dış gürültü düzeylerinden etkilenen konut yerleşim alanlarının bulunması cephelerin özellikle ısısal ve işitsel konfor koşullarını sağlamaktaki önemini arttırmaktadır. Ataköy bölgesi kuruluşundan itibaren mimari yaklaşımları ve yapım teknolojilerindeki değişimler ile ülkemizde yaşanan gelişmelerin etkilerini gösteren bir yerleşim bölgesi örneğidir. Bu çalışmanın amacı Ataköy'de farklı dönemlerde yapılmış olan farklı cephe özelliklerine sahip toplu konutlarda cephe performanslarının ısısal, işitsel konfor ve enerji harcamaları açısından değerlendirilmesidir. Bu nedenle, Ataköy'de yoğun trafik gürültüsünün olduğu bir bölgede bulunan ve benzer blok yerleşimine sahip 1950'li ve 1980'li yıllarda farklı malzeme ve cephe sistemleri ile yapılmış konut yapılarında cephe sistemlerinin etkinlikleri değerlendirilmiştir. Seçilen bloklara ait ısıtma ve soğutma enerji gereksinimleri ve ısıl konfor değerlendirmesi Design Builder simülasyon programı ile gürültü azaltım değerleri ise KS programı ile hesaplanmıştır. Cephelerinde tuğla ve beton cephe panelleri kullanılan bloklarda ısıl ve işitsel konfor ile enerji harcamalarındaki değişimin karşılaştırmalı sonuçları grafikler yardımıyla incelenmiştir.*

Anahtar Kelimeler: *Bina Kabuğu, gürültü kontrolü, enerji etkinliği.*

1. INTRODUCTION

Migration from rural areas to cities has been increasing with increasing population, increased machine use in agriculture and industrialization which can be seen easily in population statistics: increase in urban population was 20.1% between 1940-1950 whereas this shot up to 80.2% between 1950-60 [1]. Housing problems caused by increasing internal migration and fast urbanization have been attempted to be solved with different housing policies in different periods. One of these solutions is mass housing projects which refer to a high number of residential building production in a shorter time and with less investment [2]. Ensuring indoor thermal and acoustic comfort conditions in residential buildings where occupants spend extended period of times is even more important in mass housing which includes many residential buildings and affects a high number of occupants.

In traditional construction systems used in residential buildings, construction process is done on the construction site increasing the need for labour and prolonging the construction period. Therefore, also with the effect of developments in the construction industry, new actions have been taken to accelerate construction of mass housing and modular ready mixed concrete wall elements and prefabricated panel systems which allow fast production and convenience in implementation have started to be preferred. The use of precast elements in buildings such as in public housing where elements are used repetitively has increased construction speed [3]. Additionally, with the lessons learned during the oil crisis in the 1970s, efficiency in energy consumption has been popular to reduce foreign dependency [4]. Works that aim energy efficiency have also affected facade design as a result of their architectural design. Changes in building systems, facade and design decisions have been observed in buildings depending on the characteristics and developments during the period of construction.

Environmental and economic problems as a result of increased fossil fuel consumption, limited energy resources and negative effects of increasing environmental noises on people underlines the importance of architectural design decisions. Priorities in a building design include design variables such as building location, building form, position of a building relative to others, orientation of units and properties of building elements around units which affect energy consumption and noise reduction. Correct decisions about these variables will enable to provide comfort conditions in a residential building for many years with minimum energy consumption. Building façades are among the most effective design variables for creating indoor thermal and acoustic comfort conditions and determining energy loads required for controlling outdoor environment conditions. This study assesses the efficiency of facades for energy consumed to achieve thermal and acoustic comfort conditions in the mass housing blocks built using different construction systems in Ataköy district of Istanbul.

2. THE IMPORTANCE OF FACADES IN ENSURING ENERGY EFFICIENCY AND THERMAL, ACOUSTIC COMFORT CONDITIONS

Fast population growth, advances in technologies, changing consumption habits with urbanization and industrialization increase energy demand worldwide. Limited use of resources to meet increasing energy demands and environmental problems caused by the use of such resources increase the importance of studies on the concept of energy efficiency which means the most efficient use of energy resources from production to consumption. Regarding the distribution of energy consumption among industries, residential buildings have a major share in the total energy consumption. In Turkey, residential buildings are responsible for 40% of total energy consumption and majority of the energy is consumed by heating and cooling systems to achieve thermal comfort conditions [5]. The extent that the thermal comfort conditions in residential building are met with minimum energy consumption is directly proportional to how well passive systems in those buildings are designed.

Another important environmental problem as a result of increased urban population and intense urbanization today is noise. The World Health Organization (WHO) considers noise as the second most important type of environmental pollution after air pollution [6]. Control of noise which is described as disturbing, unsolicited sound and ensuring indoor acoustic comfort conditions is getting more important with increased number of sources of noise and the change in expectations about indoor comfort conditions. Indoor noise levels higher than acceptable limits have a negative effect on human health and performance. Residential areas are exposed increasingly more to environmental noises as a result of fast urbanization and industrialization which requires taking actions against environmental noises for the well-being and health of building occupants.

Building envelope design, one of the passive design decisions in buildings has an impact on both thermal and acoustic comfort conditions. Passive design decisions about the building envelope taken in the beginning play an important role in ensuring indoor thermal comfort conditions and acoustic comfort conditions with minimum energy consumption. With controlled heat transfer in the building envelope, use of man-made heating systems and related heating and cooling energy loads are reduced [7]. Additionally, with selection of the optimum building facade that has sufficient insulation during the design stage, thermal comfort can be achieved and potential comfort problems due to technical or financial matters can be prevented [8].

Therefore the building façade is the determinant factor for;

- energy consumption caused by heat losses and gains and
- noise reduction value for outdoor environment noise

is the most important design variable and has the priority in design decisions about the building envelope.

3. STUDY METHOD

Thermal and acoustic comfort conditions in the existing mass housing buildings included in this study and change in the heating, cooling and overall energy loads to achieve thermal comfort conditions depending on facade performances were comparatively assessed. For thermal comfort, operative temperature and solar radiation gains of the units and energy loads consumed to achieve thermal comfort conditions in units were calculated and for acoustic comfort, noise reduction values of building façades of the units were calculated. Design Builder simulation program was used for thermal performance evaluations and energy consumption calculations of the units with different facade properties and KS (Kalksandstein Schallschutzrechner) simulation program was used to calculate noise reduction values of facades. Design Builder program used in this study is a simulation program which uses Energy Plus simulation motor to determine thermal and visual comfort conditions and calculate energy loads. The Design Builder program runs as an interface of the Design Builder Energy Plus software program developed by the US Department of Energy and calculates hourly, daily, monthly, and annual data [9]. KS (Kalksandstein Schallschutzrechner) (V 7.03) software program used in the study is an acoustic calculation program in accordance with the ISO 12354 standards. It is used to calculate noise transfer loss of the building envelope and inner wall elements [10].

3.1. Determining building variables

Residential buildings included in this study are in Ataköy region of Bakirkoy district in Istanbul with temperate humid climate conditions in the 2. Degree Day Region of Turkey [11]. In this study residential buildings in Phase 1 which were built in the 1950s with the facade systems used in that period and in Phase 5 which were built in the 1980s with the facade systems used in that period were assessed.

Residential buildings included in the study are on a level land and on Bakırköy seaside road. These buildings are not in the shadow of other buildings. Buildings included in the study were chosen from the buildings which are closest to the seaside road and have similar orientation and outdoor noise levels. The satellite photo of the layout of the residential buildings included in the study was shown in Figure 1.

Figure 1. Layout plan of Ataköy neighbourhood.

Buildings in the phases 1 and 5 differ in building form. Therefore, thermal and acoustic performance assessments of the buildings were done in living rooms and bedrooms on which the building facade has a direct effect. Plans of residential buildings and the positions of the living rooms and bedrooms to be assessed and building facades are shown in Figure 2.

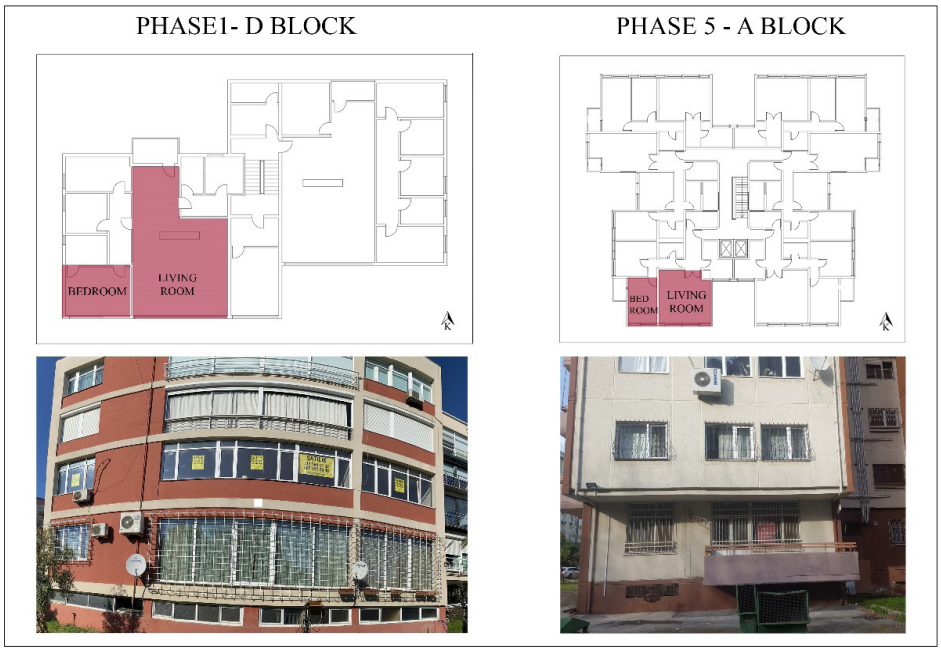


Figure 2. Building plans and views

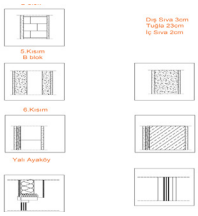
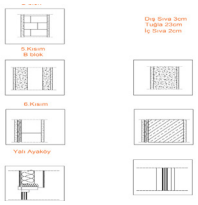
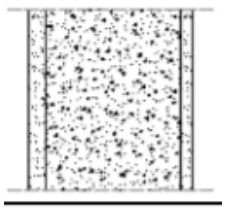
Double-glazed windows with PVC frame were used in the buildings. Total heat transfer coefficient (Up) of the windows is 1.96 W/ m² and weighted sound reduction index is Rw: 37(-2,-4). Orientation and transparency ratios of living rooms and bedrooms are shown in Chart 1.

Chart 1. Orientation and transparency ratios of living rooms and bedrooms.

	BLOCK	SOUTH	WEST
LIVING ROOM	Phase 1 BLOCK D	62%	-
	Phase 5 BLOCK A	25%	-
BED ROOM	Phase 1 BLOCK D	31%	-
	Phase 5 BLOCK A	23%	18%

Block D in phase 1 has brick facades and Block A in phase 5 has precast concrete cladding on facades. Building envelope properties of the buildings included in the study are shown in Chart 2.

Chart 2. Residential building envelope details

Block	Layering	Material	Width (m)	Density (kg/m^3)	Heat Transmission λ (W/m-K)	Heat Transfer Coef.(U) (W/m^{2}K)
PHASE 1, BLOCK D		Internal Plaster Brick Wall External Plaster	0.02 0.23 0.03	1000 1700 800	0.4 0.84 0.18	1.588
PHASE 5 BLOCK A		Internal Plaster Concrete Block Air gap Concrete Block External Plaster	0.02 0.12 0.15 0.08 0.03	1000 1800 - 1800 800	0.4 1.35 - 1.35 0.18	1.517
		Internal Plaster Concrete Block External Plaster	0.02 0.20 0.03	1000 1800 800	0,4 1,35 0,18	2,087
PHASE 1-5 BLOCK D-A		Clear Glass Air Gap Clear Glass	0.003 0.013 0.003	-	-	1,96

3.2. Calculation variables

Thermal performances of building façades were comparatively evaluated for the energy consumed to achieve operative temperature change, solar radiation gains and thermal comfort conditions. Operative temperature and solar radiation gains in units were calculated for January 21st which represents the coldest day and for July 21st which represents the hottest day of the year. In order to compare energy loads of the buildings which have different building forms, heating, cooling and overall energy load values per square meter in living rooms and bedrooms were calculated.

For all climate data about the external environment, data with epw. Extension (Energy Plus Weather) created for Istanbul in the Design Builder simulation program was used. For outdoor noise levels, noise maps developed by the Environmental Protection Department of Istanbul Metropolitan Municipality were used and the level of noise that the building façades were exposed was set at 70dBA [12].

Calculations for the residential buildings included in the study were done for living rooms and bedrooms which have the priority for achieving comfort conditions. Indoor comfort temperature was set at 20°C for the heating period and at 26°C for the cooling period in the residential buildings that are used on 24/7 basis. The limit temperature to activate the heating system was set at 18°C and the limit temperature to activate the cooling system was set at 28°C. For indoor noise and facade noise reduction values, the limit values stipulated in the Regulation on Protection of Buildings from Noise (2017) were used [13]. These values are 44 dBA for living rooms and 41 dBA for bedrooms which are D acoustic performance class values which should be met for the existing buildings. A system running on natural gas with hot water circulation was used as the heating system and electrical systems were used as the cooling system in the buildings included in the study.

4. RESULT

In this study building envelope details which change depending on the construction year of the buildings were determined and thermal and acoustic performance;

- operative temperature change and solar radiation gains,
- energy consumed to ensure thermal comfort conditions and
- noise reduction values

of the building facades were comparatively assessed. Calculation results for living rooms are shown in Figure 3 and calculation results for bedrooms are shown in Figure 4.

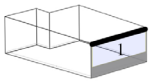
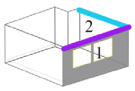
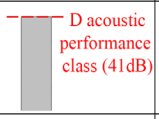
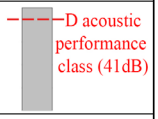
Blocks	PHASE 1 D BLOCK		PHASE 5 A BLOCK	
LIVING ROOM				
Transparency Ratio	SOUTH (%62)		SOUTH(%25)	
Facade Material	■Brick(23cm)		■Concrete Block (35cm) ■Concrete Block (20cm)	
Total Heat Transfer Coefficient (W/m²K)	Wall: U_w: 1,588 Window: U_w: 1,960		Wall: U_{w1}: 1,517 U_{w2}: 2,087 Window: U_w: 1,960	
Average operative Temperature(°C)	*21January*	*21July*	*21January*	*21July*
	7,98	32,56	6,75	28,53
Max-Min Value Difference (°C)	0,41	2,04	0,28	1
Overall Solar Radiation(kWh)	3,97	21,69	1,02	5,55
Annual Overall Energy Loads Graphic ■ Heating Loads ■ Cooling Loads				
kWh/m²	54,89		73,98	
Rw+Ctr (dB)	Rw_D: 52,3 Rw_P: 33		Rw_{D1}: 63,8 Rw_{D2}: 51 Rw_P: 33	
Rw+Ctr (dB) composite	Rw: 36		Rw: 42,3	
Dntw+Ctr				
(dB)	41		42	
Acoustic Performance Class	(D)		(D)	

Figure 3. Living room calculations

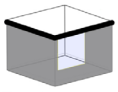
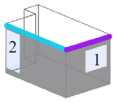
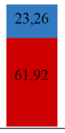
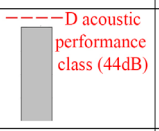
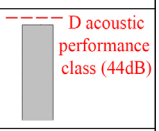
Blocks	PHASE 1 D BLOCK		PHASE 5 A BLOCK	
BED ROOM				
Transparency Ratio	SOUTH (%31)		S.O.1: SOUTH (%25) S.O.2: WEST (%18)	
Facade Material	■Brick(23cm)		■Concrete Block (35cm) ■Concrete Block (20cm)	
Total Heat Transfer Coefficient (W/m²K)	Wall: U_w: 1,588 Window: U_w: 1,960		Wall: U_{w1}: 1,517 U_{w2}: 2,087 Window: U_w: 1,960	
Average operative Temperature(°C)	*21January*	*21July*	*21January*	*21July*
	7,47	32,15	6,46	28,58
Max-Min Value Difference (°C)	0,25	1,61	0,22	0,92
Overall Solar Radiation(kWh)	1,35	7,37	0,51	2,77
Annual Overall Energy Loads Graphic ■ Heating Loads ■ Cooling Loads				
kWh/m²	85,18		104,02	
Rw+Ctr (dB)	Rw_D: 52,3 Rw_P: 33		Rw_{D1}: 63,8 Rw_{D2}: 51 Rw_P: 33	
Rw+Ctr (dB) composite	Rw: 40.5		Rw: 42.5	
Dntw+Ctr				
(dB)	40,2		40,8	
Acoustic Performance Class	(E)		(E)	

Figure 4 . Bedroom calculations

When the changes in the operative temperature and solar radiation gain values of living rooms of the buildings on January 21 and July 21 and annual changes in heating, cooling and overall energy load per square meter were calculated;

- Daily average operative temperature and overall solar radiation gain values in living rooms on January 21 which represents the heating period and on July 21 which represents the cooling period were higher in Block D in Phase 1 than in Block A in Phase 5,
- The difference between minimum and maximum values of daily average operative temperatures in living rooms on January 21 and July 21 was higher in Block D in Phase 1 than Block A in Phase 5 due to increased building transparency ratio,
- While heating loads were lower in Block D in Phase 1 which was built in 1950s than Block A in Phase 5 which was built in 1980s due to solar radiation gain, cooling loads were higher,

• None of the buildings meet the minimum requirements for total heat transfer coefficient recommended by the standard TS-825 Thermal insulation requirements for buildings as a result of the buildings' ages. Under these circumstances, annual overall energy load was higher in Block A in Phase 5 than Block D in Phase 1 and there was a 35% increase in overall energy load.

When opaque and composite component and facade noise reduction values of living rooms in the buildings were calculated;

• Noise reduction value of the opaque component was higher in Block A in Phase 5 due to the building's facade properties,

• The noise reduction value of the composite component which includes both opaque and transparent components was higher in Block A in Phase 5 with lower transparency ratio, where transparent component properties were the same but noise reduction value of the opaque component was higher,

• The noise reduction value (Dnt,w) that varies depending on outdoor noise on building facades and indoor noise sensitivity degree was high in Block A in Phase 5 due to noise reduction value of the opaque component and transparent component ratio,

• Although they were built before the Regulation on Protection of Buildings from Noise became effective, the buildings were found to meet the minimum acoustic performance class requirements stipulated in the regulation based on the choice of material, layering details and transparency component ratio in Block D in the Phase 1 and Block A in the Phase 5.

When the changes in the operative temperature and solar radiation gain values of bedrooms of the buildings on January 21 and July 21 and annual changes in heating, cooling and overall energy load per square meter were calculated;

• Daily average operative temperature and overall solar radiation gain values in bedrooms on January 21 which represents the heating period and July 21 which represents the cooling period were higher in Block D in Phase 1 than in Block A in Phase 5,

• The difference between minimum and maximum values of daily average operative temperatures in living rooms on January 21 and July 21 was higher in Block D in Phase 1 than Block A in Phase 5 due to increased building transparency ratio,

• While heating loads were lower in Block D in Phase 1 which was built in 1950s than Block A in Phase 5 which was built in 1980s due to solar radiation gain, cooling loads were higher,

• None of the buildings meet the minimum requirements for total heat transfer coefficient recommended by the standard TS-825 Thermal insulation requirements for buildings as a result of the buildings' ages. Under these circumstances, annual overall energy load was higher in Block A in Phase 5 than Block D in Phase 1 and there was a 22% increase in overall energy load consumptions.

When the opaque and composite component and facade noise reduction values of bedrooms in the buildings were calculated;

• Noise reduction value of the opaque component was higher in Block A in Phase 5 as a result of mass and material properties of the building façades,

• The noise reduction value of the composite envelope which includes both opaque and transparent components was higher in Block A in Phase 5 with lower transparency ratio, where transparent component properties were the same but noise reduction value of the opaque component was higher,

• The noise reduction value (Dnt,w) that varies depending on outdoor noise on building facades and indoor noise sensitivity degrees was higher in Block A in Phase 5 due to the opaque component and transparent component ratio

• These buildings which were built before the Regulation on Protection of Buildings from Noise became effective, failed to meet the minimum acoustic performance class requirements stipulated in the regu-

lation based on the choice of material, layering details and transparency component ratio in Block D in the Phase 1 and Block A in the Phase 5.

5. CONCLUSION

Developments throughout history have an influence also on architectural developments and based on the developments unique to each period, search for new implementation techniques, systems and materials have continued. The structural element that is affected the most by changes and developments during architectural development process is the façade [14]. It is very important to achieve thermal, visual and acoustic comfort conditions with minimum energy consumption to protect occupant health and ensure energy preservation. One of the most important functions of the building envelope which connects outdoor environment to indoors is to control physical factors such as climate, light, sound and ensure that comfort conditions needed by occupants are met with minimum energy consumption. Decisions on facades in mass housing projects which cover a high number of residential buildings will affect occupants for many years. In this study, the effects of facade decisions in buildings which were built before the standard "TS-825 Thermal insulation requirements for buildings" and "Regulation on Protection of Buildings from Noise" became effective and with different facade systems in line with the architectural developments of the years they were built were assessed. The study results are summarized below.

Regarding thermal performance and energy consumptions;

• Buildings did not meet the limit values stipulated by the thermal insulation regulation and

the transparency ratios in Block D in Phase 1 and Block A in Phase 5 which were built before 1980 had an effect on solar radiation gains and therefore on overall energy loads,

• As the transparent component ratio on the building facade increases, heating loads decrease and cooling loads increase in the living room oriented to the south. In the bedroom volumes, although there are transparent components on both sides (south and west), it was observed that heating loads increased and cooling loads decreased in the block with lower transparency on the south side.

• Based on the simulation results, depending on the changes in facade properties and transparency ratios, 99% increase in heating loads and 69% decrease in cooling loads and 34% decrease in overall energy loads in Block D in Phase 1 compared to Block A in Phase 5 were observed. %54 increase in heating loads and 65% decrease in cooling loads and %22 decrease in overall energy loads were found in bedrooms.

• Change in the facade system and transparent component ratio between blocks that have a total heat transfer coefficients which do not meet the requirements of TS 825 had more effect on cooling loads,

• Regarding operative temperature values; the value which is closest to the comfort temperature value set for January 21 was achieved in Block D in Phase 1 and the value which is closest the comfort temperature value set for July 21 was achieved in Block A in Phase 5. In this case, less energy was consumed for heating systems in Block D in Phase 1 and for cooling systems in Block A in Phase 5 in which values closest to the required comfort temperature were achieved.

According to the acoustic performance assessments;

• Noise reduction value of the opaque component was higher in Block A in Phase 5 which had precast concrete cladding, due to mass and material properties of the building facades,

• Regarding the composite component that consist of opaque and transparent components;

since transparent component properties were the same, it changed depending on the noise reduction value of the opaque component and ratio of the transparent component which has a lower insulation performance,

• Noise reduction values of building facades of living rooms in Block D in Phase 1 and Block A in Phase 5 which are located close to main roads and in a district with a high noise level were higher while noise control measures should be improved in bedrooms which are more sensitive to noise,

• Despite high outdoor noise, the buildings that were built before the Regulation on Protection of Buildings from Noise became effective in 2017 met the requirements of minimum acoustic performance class for living rooms in existing buildings however facade properties were insufficient for bedrooms which have a high sensitivity to noise.

This study found that decisions about materials, layering and transparency ratio for the facades of mass housing buildings built with different facade systems in the same district had an impact on thermal and acoustic comfort conditions and energy consumptions. Design decisions in mass housing systems in which many residential buildings are built simultaneously have a more important role than they have for single building constructions. Although residential buildings are built in accordance with the regulations that were effective during their construction, they are expected to meet comfort requirements throughout their lifespan. Fast depletion of energy resources and increasing environmental noise emphasizes the importance of assessment of existing buildings which constitute a majority of the building stock. While mass housing units which will meet comfort conditions with minimum energy and in compliance with the effective laws and regulations in new mass housing projects developed to find solutions to increasing demand for housing are being built, energy consumption and thermal and acoustic comfort conditions in old mass housing buildings which do not meet the requirements of today's regulations should also be put on the agenda.

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An Interpretive Analysis on the Heritage Values and Morphology of Tea Cultural Landscape: A Case Study on Khakiachara Tea Estate, Sreemangal, Bangladesh



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Abstract: *The Cultural Landscape of the tea garden is a metamorphosed expression of the natural landscape, which has evolved with time by setting up the tea industries in topographically suitable areas and influenced by the activities of the tea community. It is essentially a unique set of intangible and tangible features, which is not getting tourists' and researchers' perception due to lack of proper management. The study analyzes a territory in the Khakiachara tea garden, Sreemangal, and aims to showcase the existing natural and cultural setting of tea gardens by proposing an interpretive guideline. The major steps of this research are to identify the Heritage values and morphology by on-site survey and data collection, categorize them by audience perception analysis and develop a network of Cultural Heritage resources. The result of this study may provide a heritage management guideline, serve as a possible mechanism to maintain natural and cultural eco-system and boost economic development.*

Keywords: *Cultural landscape, cultural heritage, heritage values, heritage preservation, morphology, intangible heritage, tangible heritage.*

Çay Kültürel Peyzajının Miras Değerleri ve Morfolojisi Üzerine Yorumlayıcı Bir Analiz: Khakiachara Çay Bölgesi Alan Çalışması, Sreemangal, Bangladeş

Öz*:* Çay bahçesinin Kültürel Peyzajı, çay endüstrilerini topografik olarak uygun alanlarda kurarak ve çay topluluğunun faaliyetlerinden etkilenerek zamanla gelişen doğal peyzajın başkalaşmış bir ifadesidir. Esasen, uygun yönetim eksikliğinden dolayı turistlerin ve araştırmacıların algısını alamayan benzersiz bir soyut ve somut özellikler kümesidir. Çalışma, Khakiachara çay bahçesi Sreemangal›daki bir bölgeyi analiz e*tmekte ve çay bahçelerinin mevcut doğal ve kültürel ortamını sergilemeyi amaçlamaktadır. Araştırma metotları olarak yerinde anket ve veri toplama kullanılmıştır. Böylece miras değerlerini ve morfolojisini belirlemeye, bunları izleyici algı analizi ile kategorize edilmeye ve bir Kültürel Miras kaynakları ağı geliştirilmeye çalışılmıştır. Bu çalışmanın sonucu, bir miras yönetimi rehberi sağlayabilir. Doğal ve kültürel eko-sistemi sürdürmek ve ekonomik kalkınmayı hızlandırmak için olası bir mekanizma olarak hizmet edebilir.*

Anahtar Kelimeler: *Kültürel peyzaj, kültürel miras, miras değerleri, mirasın korunması, morfoloji, somut olmayan miras, somut miras.*

1. INTRODUCTION

Morphology of any particular region can be described as a summary of the interplay between landscape values, associated people and land-use practices. Tea Cultural Landscape with a synthesis of unique tangible and intangible features have tourism potentials and user demands, which is not given relative importance as a valuable heritage [1]. Among the tangible features, the tea cultural landscape has significant attractions such as historic buildings of the British colonial period, Tea factory, and temporary house structures of the tea community. The large-scale tea plantation area is the core substantial feature that attracts the tourists or visitors the most. Tea Cultural Landscape has various aspects of the material culture and intangible resources like their unique lifestyle, community activities, oral traditions, etc. as significant tourist attractions that are associated with historic buildings and sites of tea gardens, tea trading, and tea consumption [2]. These significant features can also explain the story of tea community and illustrate the morphology of tea garden areas, which are worthy of exploration and getting promoted [2]. Interpretation is considered as the most useful tool for this [3]. This article focuses on bringing out these valuable heritage resources through identifying and highlighting them keeping in their existing form so that they can get proper attention of planners and other researchers, which may help to enhance the decision-making process for future development planning by means of explanation of the local lifestyle and the pattern of cultural attribute and create positive influence on the physical settings of the local area [4].

2. LANDSCAPE FORMATION AND MORPHOLOGY OF TEA CULTURAL LANDSCAPE

Generally, tea agricultural landscape can be defined as a part of the natural landscape system that evolved and developed somewhat organically in the context of surrounding natural elements [5, 6]. A tea garden requires specific landscape formation in order to grow and sustain; and this unique natural landscape setting defines and characterizes the tea cultural landscape around the tea garden over time. The tea industry blends with the natural landscape formation of the tea garden; and is heavily influenced by the surrounding tea community and their activities. Over a span of time, cultural phenomenon occurs through the exchange of human values within the specific cultural area, in terms of technological development and landscape design, which represent the very essence of the tea agricultural landscape. In terms of tangible heritage, the tea cultural landscape is formed by a few natural and materialistic components; such as: tea factory, areas of tea plantation, connective paths and roadways, bungalows for accommodation purpose, housing facilities for tea community (known as 'coolie-line') and their community spaces etc. [1]. In terms of intangible cultural heritage, tea cultural landscape includes unique flavour of local traditions, skills, arts, music, dance, various cultural performances and rituals. Evidently, it can be assumed that a very unique cultural tradition develops, sustains, flourishes and thrives over a long period of time in the close premise of a tea cultural landscape [6]. The various transformation phases (Figure 1) of a natural landscape setting turning into the tea cultural landscape can be examined and verified as a distinguished example of cultural landscape according to the criteria mentioned in "Operational Guidelines for the Implementation of the World Heritage Convention: Criteria (paragraph 77)". Generally, the landscape formation of a hilly area or a mountainous site is suitable for developing a tea estate. The tea factory is placed right next to the main road for easy transportation and communication. Major portions of the labour community live adjacent to the tea factory, while other labour houses are scattered throughout the plantation areas, for maximum work efficiency in the estate (Figure 1). Labours sometime grow and harvest paddy in the open fertile arable land by their houses. The natural water streams alongside the hilly terrain (known as Charas) are used by the community to fulfil their need of water. Gradually, the labours build their community spaces at a suitable central location in the estate ground. Usually, the staff quarters or the bungalows are built at a higher elevation than the plantation terrace for a few strategic reasons, such as: easy monitoring and proper governance, as well as provide basic protection to the estate settlements. The transformation phases of the natural areas transforming into tea cultural landscape are depicted below.

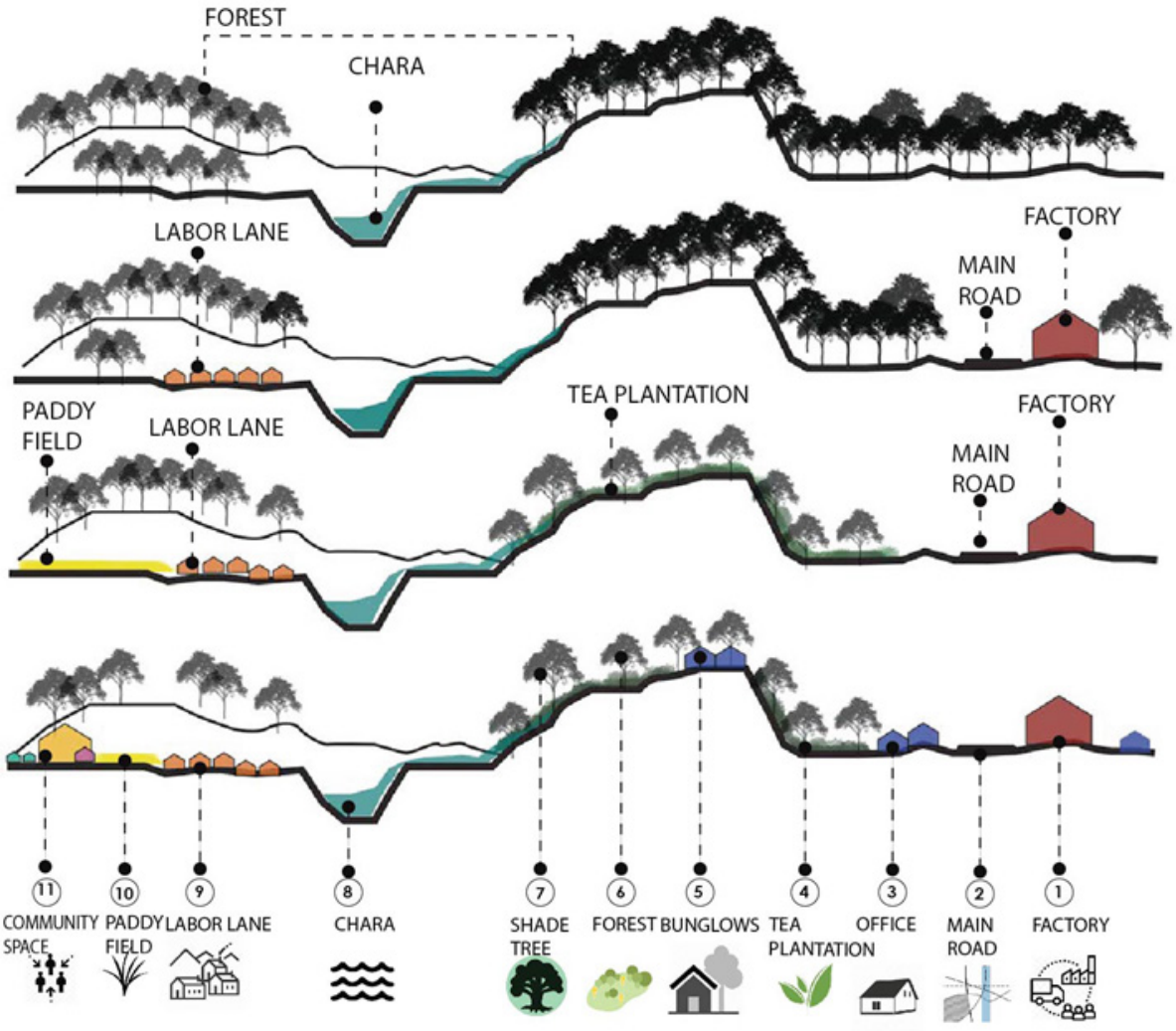

Figure 1. Transformation Phases of the Natural areas becoming the Tea Cultural Landscape

3. CULTURAL LANDSCAPE AND VALUES

A cultural landscape can be defined as a reflection of the culture and the living traditions of the people inhabiting it. This reflection and association developed by the close relationship between the tangible and intangible aspects of landscape over time [5]. *"Cultural landscapes are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal* [5]".

Cultural Landscape of any region must be seen possessing significant tangible or intangible values, associated with the activity performed or practiced by its inhabitants. These values can be classified by the terms aesthetic, archaeological, architectural, commemorative, functional, historical, landscape, monumental, scientific, social, spiritual, symbolic, technological, etc.[7]. Heritage values have been an important factor in the management process of heritage protection of different significant heritage collections, buildings, archaeological sites, landscapes and intangible expressions of culture, such as traditions [3].

4. MATERIALS AND METHODS

The discussion on the cases of heritage interpretation plan develops a guideline to create a methodological framework by incorporation with the consideration of the site context and the goals of the study. Essentially, the study includes two broad goals: (1) To showcase and promote the existing Natural and cultural setting of tea garden areas; and (2) To provide a future management guideline for Cultural Landscape conservation; To achieve these goals this research a conceptual methodological framework is prepared. At first heritage significance of the region is justified by theoretical analysis, and then an action plan is prepared after on-site survey and questionnaire survey, where visitor experience objectives are identified by value identification mapping and value analysis of the study area. The next step was categorizing the identified resources, which is an organized outline of heritage resources and can effectively showcase the region's story. At the end of the study we may achieve an existing connectivity or network of the most highlighting features of the tea garden which can be promoted by heritage interpretation. The overall research was conducted by 5 major stages:

1) The map containing the ecological structure of the study area and its connectivity with the administrative zone were collected from the concerned institutions.

2) The traditional living harmony forming the historical landscape, heritage values, historical buildings (mosques, Temples, Nachghar, Tea factory, etc.), demographic structure and cultural texture belonging to the study area within the scope of the study field were obtained from the related publications and official documents by searching the literature.

3) The evaluation strategy for assessing the heritage values is decided by the audience's perception. As audiences, the authors considered the local community or habitats who live or work here and also the tourists and visitors who generally visit the area as a tourism destination. The questionnaire survey was conducted by interviewing 100 people from the community people and visitors and 50 people from the administrative zone. An Information form was prepared to evaluate the existing heritage resources by identification of the heritage values. In the information form, oral data was gathered by questioning the current natural scenario, living facilities, physical and structural characteristics, infrastructure and transportation conditions, agricultural activities and scientific development, population and population movement of the area, educational, socio-cultural and economic situation of the people living in the area, their customs and traditions, handcrafts from the past till today, folkloric characteristics, current problems in the area, tourism facilities and resources, current situation of the other historical and cultural resources. Thus, the contributions of the people living in the area to the cultural landscape were determined. Besides, the interventions, particularly human interventions, which caused changes in the landscape of Khakiachara Tea Garden and its surroundings, were questioned[11].

4) In order to show the cultural landscape values of the area, oral data obtained by means of the information forms were analyzed. In the method of analysis, 12 criteria were used to determine the cultural landscape. These criteria were obtained by a literature survey. They were: historical importance of the region, current historical-archeological elements and sites in the area, local architecture, handicrafts, religious places, festivals and festivities, agricultural industry, transhumance tradition, associations and cooperatives, non-formal education, monumental objects and areas to be protected. A qualitative evaluation was carried out depending on the existence of these criteria within the scope of the study field. Since there was some common distribution of the cultural values when the entire area was considered, qualitative evaluation was carried out rather than quantitative one. Therefore, after analyzing the whole area six heritage values were identified. They are: Aesthetic, Historic, Scientific, Social, Symbolic and Spiritual values.

5) In the direction of these data obtained in the final stage, some maps were produced showing how the cultural values together effectively function in the study area.

5.RESULTS

5.1 Heritage Value Identification of the Study Area: A Case Study on Khakiachara Tea Garden, Sreemangal

The study selected the khakiachara tea garden and its surrounding area (Figure 2) as a sample of "Tea Cultural Landscape" which is located at Sreemangal, popularly known as the "Tea Capital of Bangladesh".

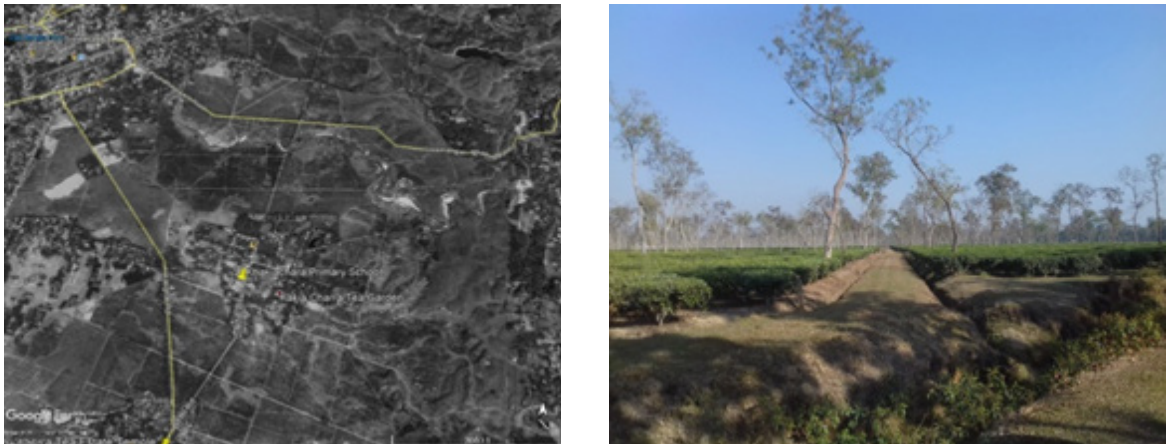

Figure 2. Map showing Study Area: Khakiachara Tea Garden (Developed by Authors)

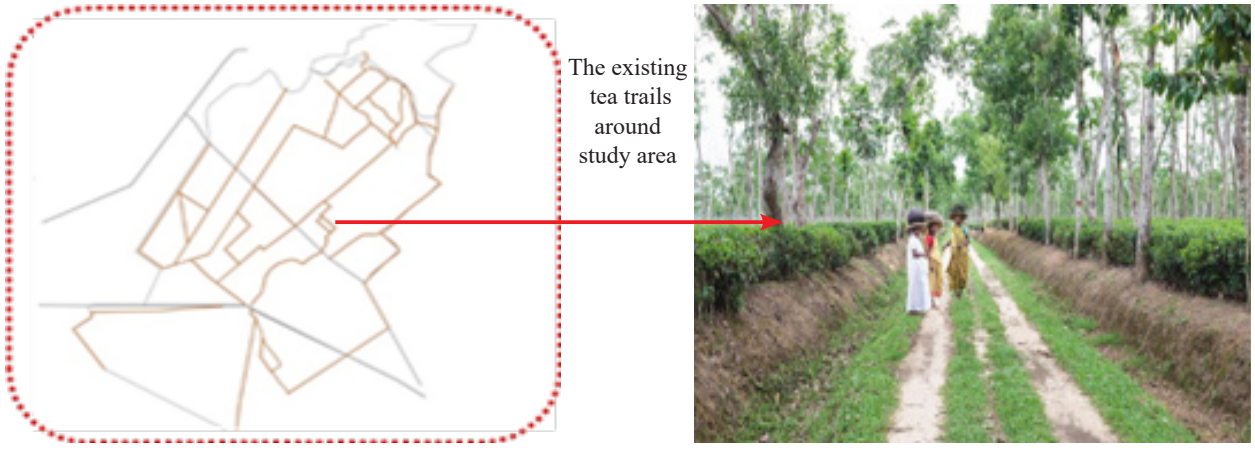

Figure 3. Map showing the Existing Tea Trails

Sreemangal is a upazila in Moulvibazar district of Sylhet region, which has become one of the dynamic centers of all activities related to trade, economy and distribution of Tea Industry of Bangladesh. This area has also developed a diverse collection of ethnic groups, who are closely associated with all types of commercial activity related to the tea industry like tea growing, producing, processing, and selling. At past times they were majorly illiterate labourers belonging to lower and downtrodden communities. When in 1837 British started the tea plantations in Assam and recruited huge number of poor, hard pressed and ignored community such as Santhal, Munda, Oraon, Khond, etc. from famine and poverty-stricken areas of Bihar, Odisha, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and West Bengal having diversity in respect of their language, tradition, culture, religion and social background on false promises such as higher wages, better life, better living conditions and at the end of contract period they would be free to go [12].

This vibrant group of people has harmonized themselves into a conjoint territory and developed a sustainable settlement pattern by sharing their norms, beliefs and practices, where together they have originated their distinct identity as the Tea community.

The first step of this research is to identify the heritage resources in the tea cultural landscape of Khakiachara tea garden. The following map is showing the identified heritage resources, which is produced by collecting data from google earth combining them with physical survey with interviewing 150 people from the local tea community and visitors and 50 people from the administrative sector of tea industry.

Figure 4. Identified Heritage resources of study area

5.2. Value Analysis according to User Perception

According to audience perception study, the identified and significant heritage resources are categorized in the table above. Firstly, the value elements were placed under three broad categories. They are: Tangible Natural Heritage Resources, Tangible Cultural Heritage Resources and Intangible Cultural Heritage Resources. Table 1 shows that, all the Tangible Natural Heritage Resources can be divided into two individual types. They are the plantation area and other natural forms like Bhurbhuria Chara (Figure 4.d), Bhanga Pahar (Figure 4.e), and Natural Viewpoint etc.

Table 1. Categorizing Tangible Natural Heritage Resources along Khakiachara Tea Garden

Values	Tangible Natural Heritage Resources							
	Plantation Areas				Natural forms			
	Tea Plantation area	Rubber Garden	Paddy Fields	Existing Tea Trails	Bhurbhuria Chara	Bhanga Pahar	Natural Viewpoint	Forest Area
Aesthetic	√	√	√	√	√	√	√	√
Historic					√			
Scientific	√	√	√	√	√	√	√	√
Social				√				
Symbolic						√		
Spiritual								

The audience perception result shows that all the natural tangible heritage elements have significant aesthetic and scientific values for their scenic beauty and important contribution in scientific research areas.

Table 2. Categorizing Tangible Cultural Heritage Resources along Khakiachara Tea Garden

Values	Tangible Cultural Heritage Resources									
	Community spaces of Tea community					Building structures of Tea Estate settlements				
	'Nachghar'	Mosque	Temple	Church	Central field	Tea Factory	Bungalows	Tea Nursery	Staff quarters	Administrative buildings
Aesthetic	√	√	√	√			√			
Historic	√					√	√		√	√
Scientific	√					√	√	√	√	√

Social	√	√	√	√	√	√				
Symbolic	√	√	√	√	√					
Spiritual		√	√	√						

The audience was highly inquisitive to contribute their opinion regarding the Intangible and Tangible Cultural Heritage values of tea garden. According to their perception, the most significant Tangible Cultural elements are found in the central community space of a tea estate. Among them the "Nachghar" (Figure 4.f) have the highest number of values and can be identified as one of the most important 'Cultural Icon' of Tea Estate. In terms of Intangible Cultural Heritage, the living style, the sense of worship and their rituals were identified containing greater heritage values.

Table 3. Categorizing Tangible Cultural Heritage Resources along Khakiachara Tea Garden

Values	**Intangible Cultural Heritage Resources**			
	Cultural activities of Tea community			
	Oral traditions of tea community	Living style	Sense of worship and rituals	Knowledge and skills
Aesthetic				
Historic	√		√	
Scientific		√		√
Social	√	√	√	√
Symbolic	√	√	√	√
Spiritual		√	√	

6. DISCUSSION

6.1. Investigation for the Existing Network of Cultural Landscape Resources with the Tea Trails

This study is a preliminary approach to introduce tea cultural landscape as a living heritage and identifying its significant values. By preserving the existing harmony between the forms and practices the natural and cultural eco-system and landscape connectivity may be conserved. The existing network of cultural landscape resources of tea gardens may serve as a possible mechanism to boost the economic development if it is promoted through encouraging tea tourism. However, 'Tea Tourism' is not completely a new concept. It is influenced by ancient history and traditions. Tea tourism encourages appreciation of the tea landscape and

other activities such as visiting tea shops and museums, tea tasting, demonstrations of tea production, participating in tea ceremonies and cultural events, tea featured accommodations, tea infused cuisine etc. [8].

In this study, the spatial structure of khakiachara tea garden has been analyzed; heritage resources are identified and then classified according to the value typology and user perception. Tea cultural landscape can be considered as a linear heritage [9]. By value analysis mapping; here the existing connection between the tea trails (Figure 3) and the heritage value elements are analyzed. The following maps are showing the heritage values through the existing tea trails by user perception analysis.

6.1.1. Assessment of Aesthetic Values along with the Study Area

The graph is prepared by the audience perception analysis regarding the heritage resources containing aesthetic values. According to the graph "Nachghar"(Figure 4.f) is the most prominent cultural element that has aesthetic values. "Nachghar"(Figure 4.f) is the local name of the community space of Tea Tribal community of the study area. This is a place where people of different religions and cultural backgrounds gather together during their festivals. "Nachghar" (Figure 4.f) is generally located at the center of the tea community living area. It is known from the audience analysis that every Tea estate commonly have a "Nachghar" Among the other natural elements, the tea plantation area (Figure 4.c) and the existing tea trails (Figure 4.c) were identified as the most popular aesthetic feature of tea gardens.

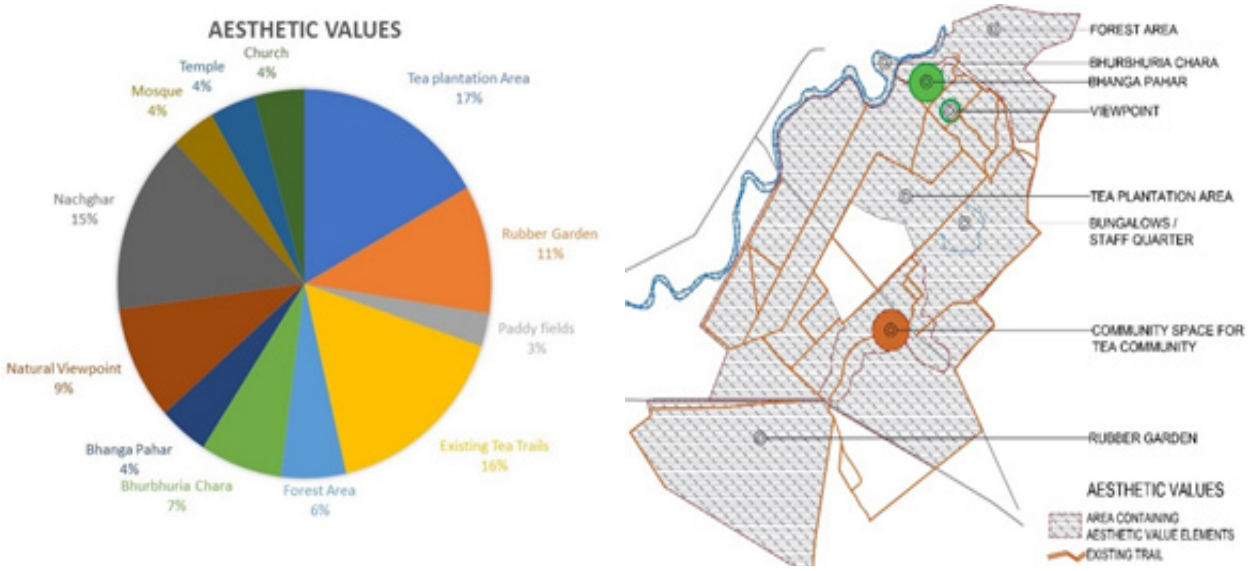

Figure 5. Graph showing assessment of aesthetic values around the study area and map showing the existing of aesthetic values with the tea trails

6.1.2. Assessment of Historic Values along with the Study Area

The graph shows majority of the built structures in tea estate settlement provide a connectedness with the past times. "Bhurbhuria Chara" is a unique historical tangible natural element, found in the study area. Among the tangible cultural elements "Nachghar" (Figure 4.f), Tea Bunglows, Tea Factory (Figure 4.a) are identified as the most valuable historic elements of a tea estate containing architectural style of British colonial period and mostly they were constructed during the rule of British government. The Unique Architectural style of these historic built structures reveals the origins of their present forms.

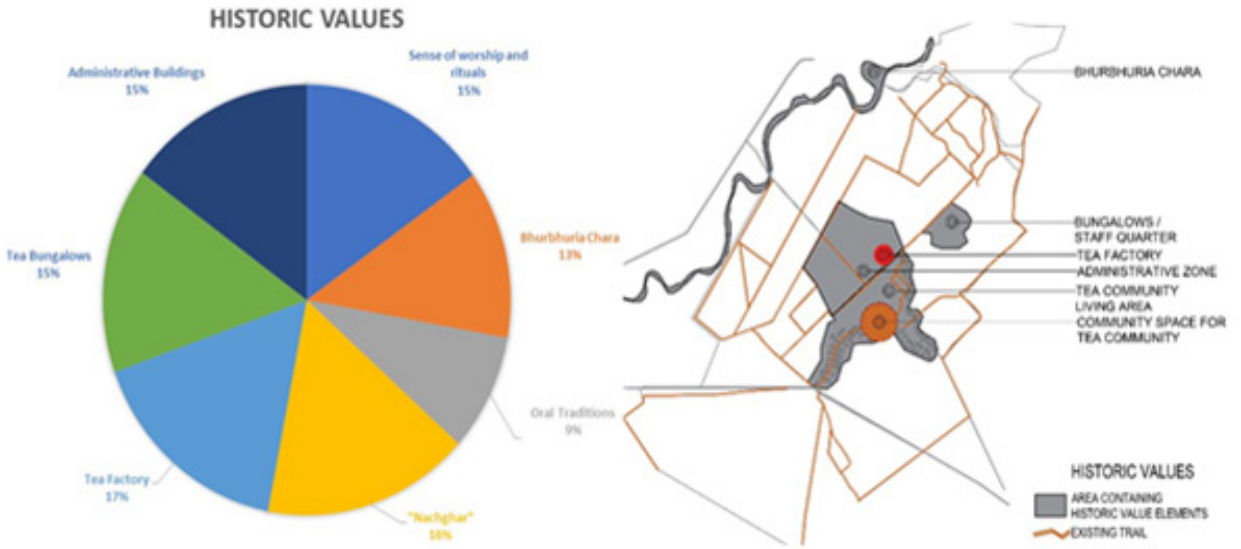

Figure 6. Graph showing assessment of historic values around the study area and map showing the existing of historic values with the tea trails

6.1.3. Assessment of Scientific Values along with the Study Area

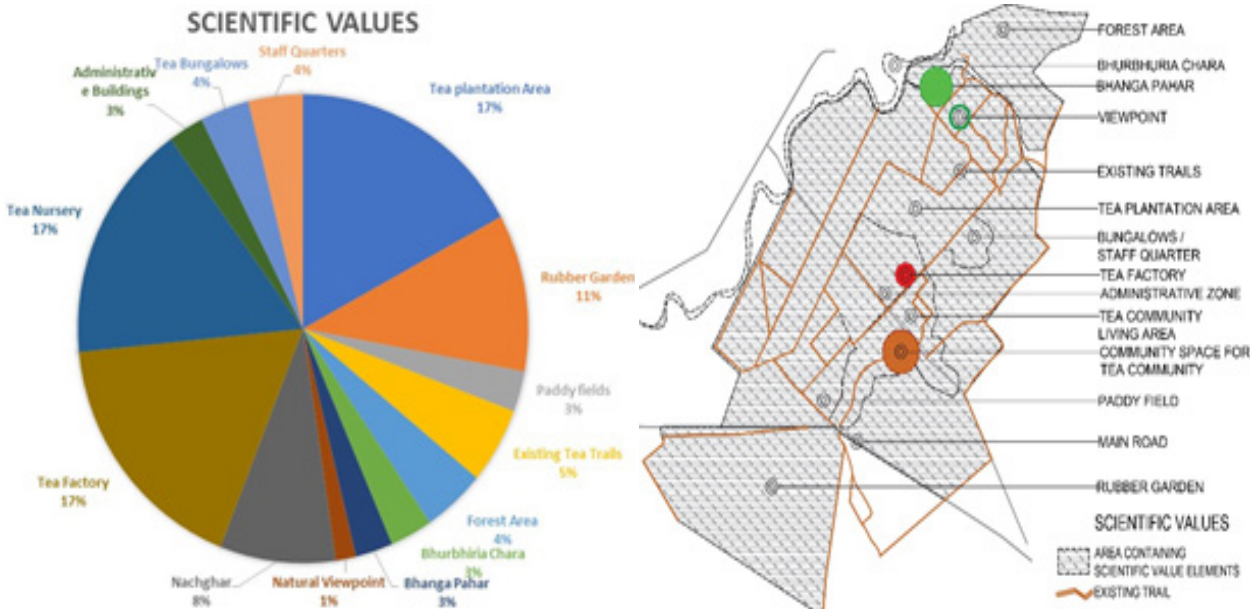

Figure 7. Graph showing assessment of scientific values around the study area and map showing the existing of scientific values with the tea trails

From the graph, it can be understood that the Tea Factory (Figure 4.a) can be considered as the most important scientific element that pulls together the whole system of a tea estate area. Tea Nursery and the tea plantation area are the key supporting elements of tea industry. The historic built forms along with the unique self-sustained cultural landscape of tea garden is an important source for scholarly study and extensive research is needed for its further development as tea industry has potential influence on our economy and also it has significant socio-cultural values.

6.1.4. Assessment of Social Values along with the Study Area

The result of the graph shows that the central community space of the tea garden confines the most prominent features of tea estate settlements, which contribute to make the whole system socially sustainable. These elements make the tea estate a desirable place in which the tea community can live and work. During their festivals, they all gather around the "Nachghar" (Figure 4.f) and Central field. Their main market place generally situated beside the central field so it contains the greatest social values from others.

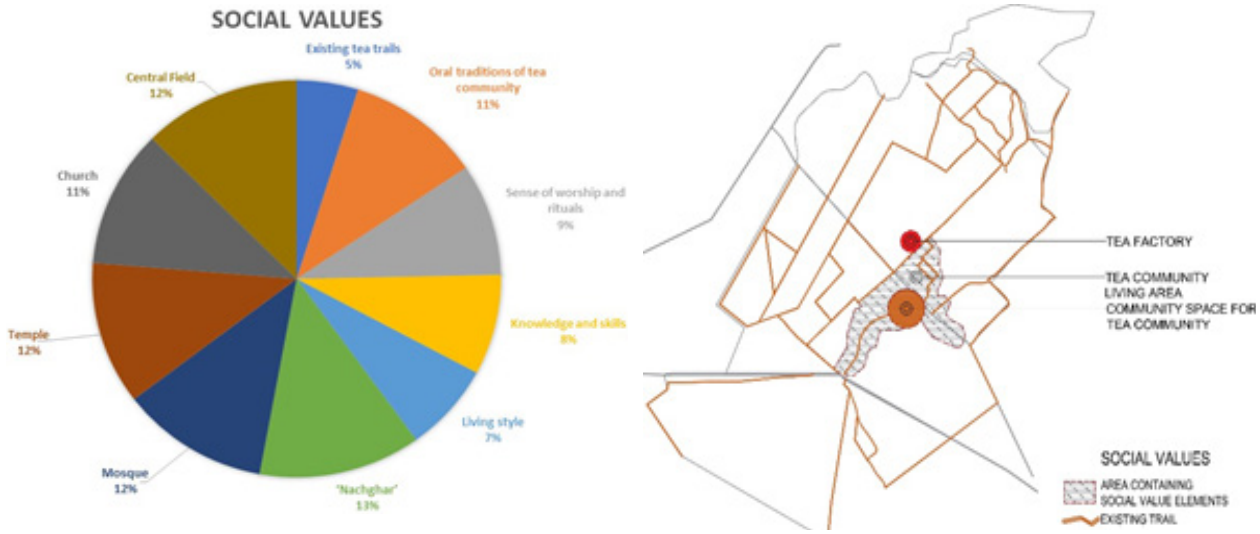

Figure 8. Graph showing assessment of social values around the study area and map showing the existing of social values with the tea trails

6.1.5. Assessment of Symbolic Values along with the Study Area

The graph explains that, in khakiachara tea garden, the "Nachghar" holds the highest symbolic value by virtue of its unique appearance and cultural individuality. Another identical natural landform of this area is "Bhanga Pahar". The tea community people collect colourful soil from "Bhanga Pahar" to decorate and paint their houses and walls.

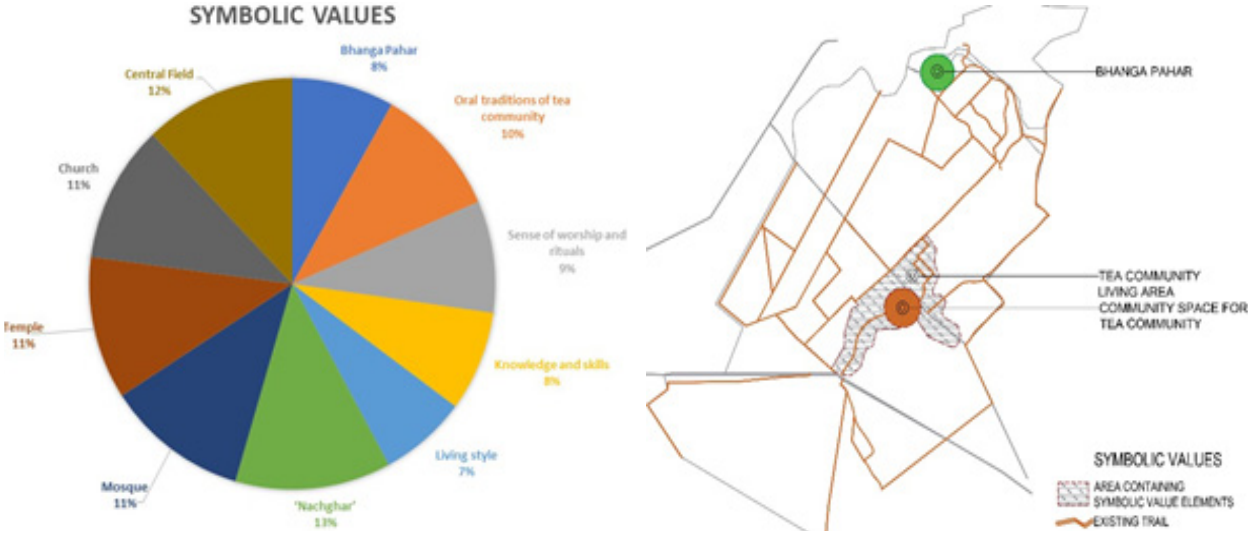

Figure 9. Graph showing assessment of symbolic values around the study area and map showing the existing of symbolic values with the tea trails

6.1.6. Assessment of Spiritual Values along with the Study Area

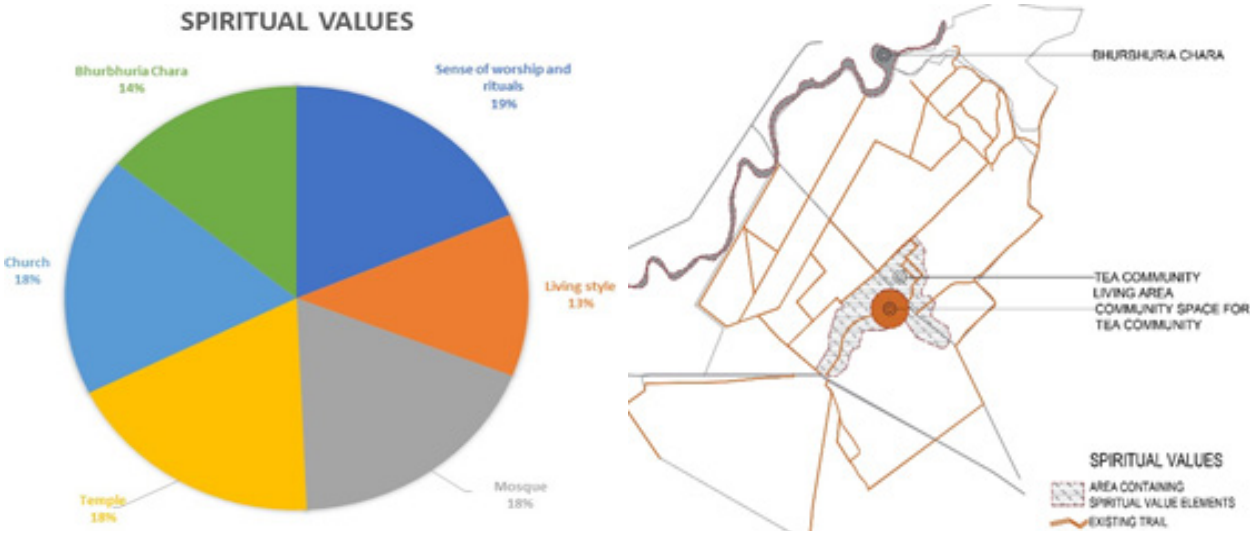

Figure 10. Graph showing assessment of spiritual values around the study area and map showing the existing of spiritual Values with the tea trails

One of the most unique and identical characteristics of Tea community people is their sensitivity about religious and spiritual aspects. Their sense of spirituality and rituals are mostly linked to the natural elements and phenomenon. For example, some particular group of people often seen to worship the natural elements like trees, water, animals etc. Even the water of "Chara" is also used during the marriage ceremonies as a part of their rituals.

7. CONCLUSION

Landscape connectivity and spatial structure of tea garden is a self-sustained and organically developed morphology that was formed and influenced by the inhabitants living in it. Tea agricultural landscape, itself has potentials to be recognized as valuable cultural landscape. But due to lack getting proper exposure this significant landscape is being ignored. Appropriate Conservation management of Cultural landscape can congregate people together to be conscious about their collective identity and heritage, and provide a shared local vision within a global context. Involvement of the local communities can vitalize the process, as they are the most effective guardians of the landscape heritage [10]. This paper is a primary initiative that explored for the heritage network and values in the existing tea cultural landscape in Khakiachara tea garden, which can help to realize the importance of protecting this valuable heritage and also can serve to guide detailed heritage management planning and designs. Therefore, the achievements of this study could also serve to improve the conservation systems of linear cultural landscapes.

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Proposals to Develop Sustainable City Center Axes Upon Case Studies: Istanbul, Erzincan, Balıkesir, Bursa, Adıyaman


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Abstract: *UN Habitat recently released a report about sustainable urbanization naming 2020-2030 as "Decade of Action" to proceed and imply actions for sustainable developments. It is indicated that impacts of pandemics, climate change and inequality raised necessity of sustainable cities. Not only focusing on renewable energy issues, but also accessibility, cultural continuity and localization are needed to be emphasized. This study contains student projects in "Sustainability and Architecture" course in Architecture, focusing on examination of city centre axes and investigation of problems related to environmental, social and economic sustainability issues for Erzincan, Balıkesir, Bursa, Adıyaman and Istanbul. In this context, problem investigation methods: site observations, examinations of local dynamics, statistical data analysis of government and literature reviews. After evaluating the problems, to improve life quality and resiliency of cities, the proposals involve matrix-based tables and 2D&3D drawings. Consequently, this study aims to be a start of "Decade of Action" which can be adapted to different cities in future researches.*

Keywords: *Sustainable urbanization, Resilience, Sustainable development, city center design, urban sustainability indicators.*

Sürdürülebilir Şehir Merkezi Aksları Geliştirme Önerileri Alan Çalışmaları: İstanbul, Erzincan, Balıkesir, Bursa, Adıyaman

Öz: *Birleşmiş Milletler Habitat programı, kısa süre önce 2020-2030 yılları arasını sürdürülebilir şehirleşme için "harekete geçilmesi ve aksiyon alınması gereken on yıl" olarak ilan ettiği bir rapor yayınlamıştır. Bu raporda pandemi etkileri, iklim değişikliği ve eşitsizlik gibi konuların sürdürülebilir şehirlere olan gereği arttırdığı vurgulanmıştır. Sadece yenilenebilir enerji konuları değil, bunun yanında erişilebilirlik, kültürel devamlılık ve yerelleşme konularına da odaklanılmasına ihtiyaç duyulmaktadır. Bu çalışma, "Sürdürülebilirlik ve Mimarlık" dersi kapsamında şehir merkezlerinin incelenmesini, çevresel, sosyal ve ekonomik sürdürülebilirlik ile ilgili problemlerin araştırılmasını ve problemi ortaya koymayı amaçlayan öğrenci projelerinden yola çıkmaktadır. Bu bağlamda, araştırma yöntemi olarak saha gözlemleri, yerel dinamiklerin incelenmesi, istatistiki verilerin analizi ve literatür araştırmaları yapılmıştır. Problemlerin değerlendirilmesinden sonra; şehirlerin yaşam kalitesini arttırmayı amaçlayan, şehir akslarına farklı koşullara karşı dayanım ve esneklik getiren öneriler geliştirilmiştir. Bu öneriler matris tabanlı tablolardan ve hem iki hem de üç boyutlu görsel temsillerden oluşmaktadır. Sonuç olarak, bu çalışma "harekete geçilmesi ve aksiyon alınması gereken on yıl" için bir başlangıç noktası olmayı amaçlayarak gelecek çalışmalarda başka benzer özellikteki şehirlere uyarlanabilecek rehber öneriler sunmaktadır.*

Anahtar Kelimeler: *Sürdürülebilir şehirleşme, Rezilyans, Sürdürülebilir gelişme, Şehir merkezi tasarımı, Kentsel sürdürülebilirlik göstergeleri.*

1. INTRODUCTION

United Nations (UN) Habitat has prepared a report to succeed in sustainable urbanization development with an aim of providing a better world for future generations. The report is a kind of manifesto calling the years between 2020-2030 as "Decade of Action" to achieve concrete objectives in sustainability in environmental, social and economic perspectives. This report consists of analysis, tools and methods to maintain the life cycle independently and provide the needs adequately in the cycle. The report is not only introducing the global approaches but also includes the unquantifiable value that gives cities their unique character; and also explores the role of innovation and technology, local governments, targeted investments and the effective implementation of the New Urban Agenda in fostering the value of sustainable urbanization [1]. Moreover, socio-economic problems like migration, poverty, housing, unemployment are examined in detail and an integrated schema of sustainable city planning is organized. Furthermore, the year 2020 symbolizes a turning point for the whole world which should be considered as a last warning towards humankind due to their treatment of the Earth. The coronavirus pandemic -as it is the worst public health crisis since the Spanish Flu in 1918- is witnessed in the whole world and economic turndowns have appeared in different countries which increase inequality, poverty and unemployment. For more than twenty years, destructive impacts of environmental problems -which are the results of uncontrolled human activities, excessive urbanization / rapid urban growth and excessive industrialization- are harshly seen and felt in daily life such as climate change, endangered species, pandemics. In consideration of these important issues; the development of sustainable cities is becoming urgent and indispensable; as the majority of the world's population lives in urban areas. According to United Nations (UN), 55% of the world's population lives in urban areas and it is forecasted to reach 60% by 2030 and 68% by 2050 [2]. The percentage of the urban population in Turkey is reported as 76% in 2020; and is expected to increase more in upcoming years [3]. While urbanization is often positively correlated with socioeconomic improvement, it has resulted in several environmental problems [4, 5, 6, 7]. Regarding these researches, urban sustainability planning is the necessity of maintaining livable environments for future generations.

According to Sasanpour [8]; the city is a phenomenon that has evolved in history, the result of culture and spatial effects of playing the basic roles of man in the geographical environment and having various dimensions of the environmental, historical, cultural, political, economic, social, and psychological. Hence, a comprehensive understanding of the city is possible by knowing all its dimensions and components [8].

Urban sustainability is classified into three aspects: environmental, social and economic. As Huang, Wu and Yan [9] defined urban sustainability as "an adaptive process of facilitating and maintaining a virtual cycle between ecosystem services and human wellbeing through concerted ecological, economic, and social actions in response to changes within and beyond the urban landscape"[9]. In this study, the ultimate goal is to reach sustainable city center development within the balanced integration of these three prospects.

Urban sustainability is fundamentally a dynamic process of harmonizing the environment, economy, and society in an urban area through design, planning, and institutional activities [9]. In this study, urban sustainability indicators were considered to provide information about the functioning of a specific urban system, for a specific purpose of sustainability to support decision-making and management of the whole urban system. This study emphasizes the necessity of defining urban sustainability indicators in order to measure urban sustainability properly. European Environment Agency's Urban Metabolism Framework, European Union's European Green City Tool, European Foundation for the Improvement of Living and Working Conditions' Urban Sustainability Indicators, Reference Framework for Sustainable Cities (RFSC) are some existing urban sustainability indicator sets. Due to the overpopulation of indicators, there is a need to bring out the most important and relevant ones [10]. According to Huang, Wu and Yan [9], using different kinds of indicators in concert or combining single indices with indicator sets in the same assessment can also provide useful information for confirmation and comparison of results. Thus, in this study, necessary urban sustainability indicators were selected and accordingly, considered to define solutions for particular city center axis. The indicators were evaluated in three main aspects: environmental, social and economic (Table 1). In this study, as shown in Table 1, the environmental indicators were defined as green spaces, energy efficiency, mobility, air quality, waste – reuse – recycle and disaster management; social indicators were quality of public space, urban safety, heritage, awareness, accessibility and nuisance; economic indicators were tourism, local economy, life cycle management of urban properties in terms of materials, structures and systems, and idle buildings.

URBAN SUSTAINABILITY INDICATORS		
Environmental Indicators	**Social Indicators**	**Economic Indicators**
Green Spaces	Quality Public Space	Tourism
Energy Efficiency	Urban Safety	Local Economy
Mobility	Heritage	Life Cycle Management
Air Quality	Awareness	Idle Buildings
Waste / Reuse / Recycle	Accessebility	
Disaster Management	Nuisance	

Table 1. Urban Sustainability Indicators according to three sustainability aspects (Compiled by authors).

In this study, existing city axis was targeted to improve by considering urban sustainable in terms of environmental, social and economic in order to obtain resilience cities as it was indicated in the UN's report for the near future. In Turkey, there are various kinds of cities in terms of geographical, climatic, demographic and economic aspects. In this study, the objective was defined to propose a sustainable transformation prototype for different cities. Five different cities which have own characteristics were examined in detail. For instance, Istanbul is the highest populated and densest city with numerous districts showing various features. While Erzincan has harsh climatic conditions with the lowest population. Bursa and Balıkesir are both example for large-scale cities. However, Bursa is center for industrialized areas, whereas Balıkesir is more focused on tourism. On the other hand, Adıyaman is a medium scale city that its economy based on agriculture in the southeast of Turkey.

The aim of this study is to measure and define the existing conditions of selected five different axes in terms of urban sustainability from environmental, social and economic perspectives; and to propose a model of sustainability transformation of selected axis in urban scale which should be considered as a prototype that can adapt to similar urban areas.

2. MATERIALS AND METHODS

This research gathered the findings of students' projects in "Sustainability and Architecture" and transformed these findings into a systematic evaluation method for sustainable developments in city center axis. The project was required students to work individually in their hometowns where they were continuing distant learning as result of coronavirus pandemic. In this study, student projects were considered as data sets; in order to develop the model, the datasets were analyzed, categorized and evaluated in detail according to indicator-based sustainability assessment. The course was conducted in Architecture Department of Beykoz University in the 2020-2021 fall semester.

Five different axes were examined from five different cities in Turkey: Istanbul, Erzincan, Balıkesir, Bursa, Adıyaman. These cities were located in different regions of Turkey; each showed unique characteristics (Figure 1). The methodology covered three steps: the first step was description of selected axes. The second step was identifying sustainability problems and the third one was developing proposals according to the urban sustainability indicators.

The first step was selection of city center axes in the city which were combination of both residential and trade areas. Secondly, to identify problems for sustainability in environmental, social and economic perspectives; site visits, observations including sketches and photography, statistical data collection from local and governmental authorities and literature reviews to understand the local dynamics such as historic, cultural background information and transformations were analyzed in detail. The analysis related to connectivity, accessibility, transportation and density were made. The problems were highlighted graphically in the maps of axes together with the photographs about existing conditions. The third step was proposal of design criteria along with sustainable axis design for each city. Additionally, two- dimensional and three-dimensional representations were prepared in order to illustrate sustainable solutions. As the final step; suggestions were made to respond each particular problem. This step was composed of matrix-tables which included problems, solutions and related urban sustainability indicator.

Figure 1. Location of cities in Turkey (Drawn by authors).

In this study, five different cities which are differentiated at HDI rankings of UN that considers the health, education and income for human development, 4 to 59 in Turkey. According to Forbes global livability index which compares cities with each other in terms of security, affordability, education, healthcare, its urban lifestyle and infrastructure about liveability, Istanbul is the first, Bursa, Balıkesir, Erzincan and Adıyaman respectively; as Adıyaman is the last in the selected cities with being number 70 (Table 2).

Table 2. Statical Data for each city (Compiled by authors).

City	Region	Population (TUİK)	Urban Population (TUİK)	Area (km2)	HDI Ranking (2017) (UN)	Forbes (2020)
Istanbul	Marmara	15 520 000	15 520 000	5461	4	1
Erzincan	East Anatolia	234 431	191 061	11903	36	46
Balıkesir	Marmara - Aegean	1 227 000	662 199	1454	29	15
Bursa	Marmara	3 056 120	286 159	1036	17	8
Adıyaman	South East Anatolia	632 459	411 098	1679	59	70

The reasons behind these rankings were tried to be evaluated and sustainability problems that were related about selected axes were questioned. In this regard, European Commission's Science for Environment Policy was examined in detail and a new evaluation criterion with urban sustainability indicators in order to survey environmental, social and economic sustainability were proposed. The methodology of defining the urban sustainability indicators was choice and interpretation of the indicators from the large set of Reference Framework for Sustainable Cities (RFSC) and European Foundation for the Improvement of Living and Working Condition's Urban Sustainability Indicator frameworks. In consideration of local problems and dynamics of the focused axis, not the whole city, the proposed evaluation criteria have been developed as an integration and localization of them. Each axes were analyzed qualitatively and evaluated according to the urban sustainability indicators (Table 1) and specific solutions were proposed and shown in Table 2-6.

3. RESULTS

3.1. Istanbul – Arnavutköy District Project

Istanbul is the most crowded metropolitan city of Turkey, which consists of 39 districts. Istanbul is a multi-centered city and, in this study, focal axis is Fatih Street which is located in Arnavutk**ö**y district. Even though its roots are from Roman Era, Arnavutk**ö**y is one of the newest districts of Istanbul as it became a district in 2008 [11]. It is a district in the northern part of its European side, located near the Black Sea, which has a total area of 506.52 km², has become the fourth largest district in Istanbul in terms of land size. By the construction of new Istanbul Airport in this district, it is growing in terms of urban structure. Now the population of Arnavutk**ö**y is 282 488. The selected axis is Fatih Street on which high density of vehicle and pedestrian traffic exist. The axis starts from BP Gas Station and ends in Arnavutk**ö**y Governmental

Hospital. The selected axis is 1 km long and includes Cumhuriyet Square, Arnavutköy Primary School, shopping areas and residential buildings. It is route for bus and minibus public transportation types.

Within the scope of this study, problems are determined. As this axis is located in Istanbul which is in the 1st degree earthquake zone. Although Arnavutköy is considerably less risky district in Istanbul, according to Istanbul Metropolitan Municipality (IBB) 284 buildings are expected to damage highly and very highly [12]. Specific sustainability problems about axis that defined in this study. The specific problems for Istanbul – Arnavutköy district, axis of Fatih Street is shown in Table 2. Problem about green spaces is lack of open green areas. There are important problems about mobility; can be listed as pedestrian circulation problems such as lack of crossover, not being able to cross the street in the school area, public transportation route interrupts the pedestrian circulation and high density of vehicle traffic. Insufficiency of parking areas result in parking on the pavement and blockages of the streets. Due to the high traffic and crowd; there is nuisance problem of noise. Another negative effect of high density of traffic is excessive amount of exhaust gas which leads to unhealthier air quality. In addition to these problems; undesired aspects of uncontrolled urbanization, buildings' facades without plasters and finishing materials are exist, there is no standardization on signboards, HVAC external units and TV satellite dishes on the facades which ends up in visual pollution. There is not enough open space in terms of quantity and quality for people to relax, socialize or do sport; as well as lack of green areas. There is an existing green area but the way that leads to this green area is unsafe in terms of security; so, it is not possible to use this are effectively as it is planned. Along the axis, various cafes and restaurants causes heavy food odour. Although there are lots of shopping areas and cafes, accessibility to them is another problematic issue. It is not possible to reach the units and walk continuously; both ramps and visually impaired paths are missing. Existing urban furniture are in poor conditions; there are not selected suitably for outdoor usage. Also, it is not safe anymore to use weared furniture for people. Along the axis, recycle boxes are missing which is the essential for environmental sustainability. In the meantime, there is necessity to raise the awareness of people about accessibility and recycle specifically.

The specific sustainable solutions for the selected axis are classified in different areas: solutions about mobility issues are increasement of pedestrianly movement based transportation, implementing a crossover for accessing school, continuous pedestrian paths providing same width along the axis, implementing a bicycle path to the existing road, new route for public bus transportation, increasement of traffic signs to prevent accidents and excessive usage of car horn, underground parking lots that ground levels are designed as open green public areas and encouraging electrical cars from macro scale by adding battery units in gas station on the axis.

Table 3. Sustainability related problems – solution matrix for Istanbul (Compiled by authors).

			SUSTAINABILITY SOLUTIONS																				
ISTANBUL- ARNAVUTKOY DISTRICT: THE AXIS ON FATIH STREET			Increasement of pedestrian/cycle movement based transportation	Implementing crossover for approaching school	New route for public bus transportation	Continuous pedestrian paths providing same width	Implementing a bicycle path to the existing road	Encouraging electric cars from macro scale	Underground parking lots	Integration of ramps and visually impaired paths	Assigning social functions like cafés, bufes, galleries on the way	Increasement of night lighting based on solar energy	Increasement of traffic signs	Assigning sound absorber façade panels on buildings' ground level	Assigning environmental friendly external wall systems	Standardization about signboards	Mesh panel systems for HVAC external units	Reconsidering the mechanical ventilation systems for cafés' kitchens	Afforestation on the axis	Transformation of disserned areas to green public spaces	Reuse and recycle of existing urban furniture and equipment	Placement of recycle boxes for each 400m
SUSTAINABILITY ASPECTS	URBAN SUSTAINABILITY INDICATORS	SUSTAINABILITY PROBLEMS																					
Environmental	Green spaces	Lack of quality open public spaces.																		X	X		
	Energy efficiency	Facades without plasters and finishing materials.										X		X	X								
		Heat Island effect													X				X				
	Mobility	Pedestrian circulation problems.	X	X	X	X	X						X										
		High density of vehicle traffic	X		X																		
		Lack / Insufficiency of parking areas							X														
	Air Quality	Excessive amount of exhaust gas.					X	X															
	Waste / Reuse / Recycle	Insufficiency of trash boxes and lack of recycle boxes.																					X
		Old and wasted urban furniture																				X	
	Disaster Management	Insufficiency of earthquake and disaster assembly areas.																			X		
	Quality Public Space	Lack of quality open public spaces.																			X		
	Urban Safety	Unsafe conditions of pedestrian paths / overpass/underpass									X	X	X										
Social	Heritage	NONE																					
	Awareness	Accessibility								X													
		Recycling																					X
	Accessibility	Lack of ramps								X													
		Lack of visually impaired paths								X													
	Nuisance	High level of noise											X	X					X				
		Visual pollution (unplastered facades, AC units, signs..)													X	X	X						
		Food / Exhaust odour types.																X	X				
Economic	Tourism	NONE																					
	Local Economy	Insufficiency of social services									X												
	Life Cycle Management of Urban Properties (Materials, Structures, Systems)	Wasted urban furniture																				X	
	Idle Buildings	NONE																					

Integration of ramps and visually impaired paths are designed for the entrances of buildings, pedestrian paths and crossovers. In order to use existing green area efficiently; night lightening system based on solar energy and social functions like cafés, restaurants, and galleries on the way to the park are assigned. Also, this large green area is considered as earthquake and disaster assembly area. Afforestation on the axis, increasement of traffic signs to prevent accidents and excessive usage of car horn and assigning sound absorber façade panels to the trading functions on the ground level to solve nuisance problem due to the high level of noise from traffic, crowd and density. Standardization about advertisement signboards and mesh panel systems for HVAC external units are proposed to solve visual pollution. Reconsidering the mechanical ventilation systems to evacuate from kitchens of cafes and restaurants is suggested for the decrease food odor that comes from cafes and restaurants. In the axis, to solve problem about facades; assigning environmentally friendly façade solutions with recycled thermal insulation, recycled wooden panels and green façade solutions are suggested. Reuse and recycle of existing urban furniture are planned and if necessary, to design new high durability and environmentally friendly urban furniture. Placement of recycle boxes for each 400 m is planned.

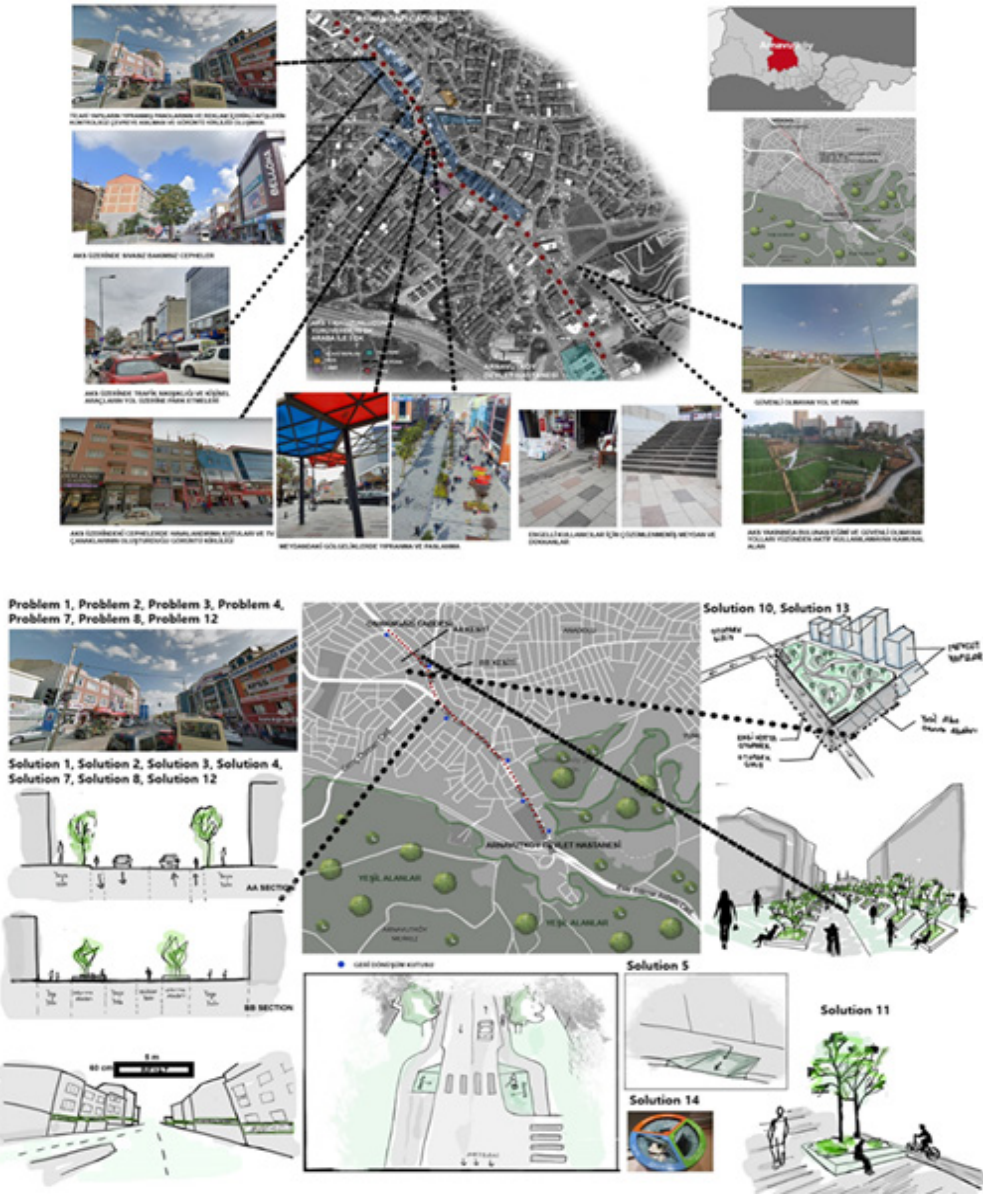

Figure 2. Description and sustainability proposals for the axis in Istanbul, Arnavutköy by Y. Beyçimen.

3.2. Erzincan

Erzincan is a city located in the Eastern part of Turkey; its descents are to the BC 387. Erzincan is a medium-sized city with a total area is 11903 km2 and the population is 234 431 [13]. Erzincan has a continental climate with freezing, snowy winters and hot and dry summers. There are some kind of renewable energy sources in use in Erzincan such as solar power plants and hydroelectric power plants.

The selected axis is composed of Halit Paşa and Fevzi Paşa Streets; the streets meet in Dörtyol Square; that is main square of Erzincan where high density of vehicle and pedestrian traffic exist. The axis starts from Erzincan Municipality Building and ends in Terzibaba Mosque. The selected axis is 2 km long and includes shopping areas and offices. It is route for bus and minibus public transportation types.

One of the main problems of Erzincan is earthquake. Throughout the history, the city suffers from various earthquakes; the strongest ones are in 1939 and 1992. Specific sustainability problems about axis are defined and shown in Table 4.

Table 4. Sustainability related problems – solution matrix for Erzincan (Compiled by authors).

ERZİNCAN: THE AXIS ON HALİT PAŞA AND FEVZİ PAŞA STREETS			SUSTAINABILITY SOLUTIONS														
SUSTAINABILITY ASPECTS	URBAN SUSTAINABILITY INDICATORS	SUSTAINABILITY PROBLEMS	Increasement of pedestrianial movement based transportation.	Implementing crossovers and traffic light at some points on the axis.	Placement of new bus stops.	Continuous pedestrian paths providing same width.	Implementing a bicycle path to the existing road.	Encouraging electrical cars from macro scale.	Underground parking lots.	Integration of ramps and visually impaired paths.	Assigning social functions like cafés, bufes, galleries on the way.	Afforestation on the axis.	Transformation of idle open areas to green public spaces.	Reuse and recycle of existing urban furniture and equipment.	Reusing the existing pavement by applying top coat solutions against slipperiness or roughening the pavement material.	Placement of recycle boxes for each 400m.
Environmental	Green spaces	Lack of green spaces.										X	X			
	Energy Efficiency	Heat Island affect.										X	X			
	Mobility	Pedestrian circulation problems.	X	X	X	X	X									
		High density of vehicle traffic.	X				X									
		Lack / insufficiency of parking areas.							X							
	Air Quality	Excessive amount of exhaust gas.	X				X	X								
	Waste / Reuse / Recycle	Insufficiency of trash boxes and lack of recycle boxes.														X
		Slippery Floor Finishes of Pavements.													X	
	Disaster Management	Insufficiency of earthquake and disaster assembly areas.											X			
	Quality Public Space	Lack of quality open public spaces.				X					X	X	X			
	Urban Safety	Unsafe conditions of pedestrian paths /overpass/underpass.									X				X	
	Heritage	NONE														
Social	Awareness	Accessibility								X						
		Recycling												X	X	X
	Accesibility	Lack of ramps.								X						
		Lack of visually impaired paths.								X						
	Nuisance	Exhaust odour.										X				
	Tourism	NONE														
	Local Economy	Insufficiency of social services.									X					
	Life Cycle	Slippery Floor Finishes of Pavements.												X	X	
Economic	Management of Urban Properties (Materials, Structures, Systems)	Unusage of ornamental pool.										X	X	X		
	Idle Buildings /Structures	Idle and unemployed pedestrian overpass which people usually do not prefer to use.									X					

There are problems about mobility: existing pedestrian circulation areas are narrow; there is high density of vehicle traffic that causes excessive amount of exhaust gas leading to low air quality. Insufficiency of parking areas in the axis result in parking on the pavement and blockages of the streets. There is an idle and unemployed pedestrian overpass which people usually do not prefer to use that causes unsafety urban

environment and affects connectivity in a negative manner. There are no bicycle roads. Even though, there is bus and minibus lines passing through the axis, their stops are not defined; vehicle can easily park to bus stop without recognizing it. The pavements are made of slippery materials that causes damages for people especially in winter during rain, snow and frost. Integration of ramps and visually impaired paths are not designed that causes accessibility problems. There is no recycle bins along this axis to maintain lifecycle management. A quality open space and green areas are missing; which can be considered as also earthquake assembly areas. There is an ornament pool in the midpoint of the axis; but it is not working.

The specific sustainable solutions for the selected axis are classified in different areas: solutions about mobility issues are increasement of pedestrianly movement based transportation, implementing crossovers and traffic lights, continuous pedestrian paths providing same width along the axis, implementing a bicycle path to the existing road, placement of bus stop, increasement of traffic signs to prevent accidents, underground parking lots that ground levels are designed as open green public areas and encouraging electrical cars from macro scale by adding battery units on the axis. Integration of ramps and visually impaired paths are designed for the entrances of buildings, pedestrian paths and crossovers. In order to improve green areas, afforestation on the axis and transformation of idle open areas and car parking areas to green public spaces are designed. Also, these green areas are considered as earthquake assembly area. Transforming unemployed overpass into a small-scale green street bazaar to improve local economy are planned. Reusing the existing pavement by applying top coat solutions against slipperiness or roughening the pavement material are designed and transforming the unused ornamental pool into seating area with green is planned. Placement of recycle boxes for each 400 m is planned.

Figure 3. Description and sustainability proposals for the axis in Erzincan by A. Adan

3.3. Balıkesir

Balıkesir is located both in the Marmara and Aegean regions in the Western part of Turkey. The roots of city are from Ancient Greek; but urban settlements are from Roman Era. Historic center of Balıkesir which majority of buildings were constructed at the end of the 19th century during the Ottoman Era has a population more than 1 227 000, it is the fourth crowded city in the Marmara Region [14]. The total area of Balıkesir is 1454 km2; it has sea coasts and shores to both Marmara and Aegean Seas. The city is well-connected with other cities by highways, railway and airway. The main economic incomes are agriculture and tourism which is based on summer and spa tourism. Balıkesir has a hot-summer Mediterranean climate; winters are cool and wet with frequent frosts and summers are hot and dry. The selected axis is Anafartalar Street which is located in the historic center of the city. The axis begins from historic Zağnospasa Mosque that is constructed in the 15th century and ends in Kasaplar Mosque. Along with the axis, there are historic Ziraat Bank building, Kuvayi Milliye Museum, Library, Clock Tower, shopping areas and historic but abandoned buildings. The main complaints about the city center are air pollution, traffic, lack of parking areas, lack of social functions and insufficiency of green areas [15].

Table 5. Sustainability related problems – solution matrix for Balıkesir (Compiled by authors).

			SUSTAINABILITY SOLUTIONS												
BALIKESİR: THE AXIS ON ANAFARTALAR STREET			Increasement of pedestrian/all movement based transportation.	Implementing a bicycle path to the existing road.	Encouraging electrical cars from macro scale.	Underground parking lots	Integration of ramps and visually impaired paths.	Restoration, renovation and refunctioning the abandonment area	Assigning social functions like cafés, bufes, galleries on the way.	Increasement of night lighting based on solar energy.	Increasement of traffic signs	Afforestation on the axis.	Transformation of idle open areas to green public spaces.	Placement of recycle boxes for each 400m.	
SUSTAINABILITY ASPECTS	URBAN SUSTAINABILITY INDICATORS	SUSTAINABILITY PROBLEMS													
Environmental	Green spaces	Lack of quality green spaces										X	X		
	Energy efficiency	Heat Island affect										X	X		
	Mobility	High density of vehicle traffic	X	X							X				
		Lack / Insufficiency of parking areas				X									
	Air Quality	Excessive amount of exhaust gas.	X	X	X										
	Waste / Reuse / Recycle	Insufficiency of trash boxes and lack of recycle boxes.													X
	Disaster Management	Insufficiency of earthquake and disaster assembly areas.											X		
	Quality Public Space	Lack of quality open public spaces.						X					X		
Social	Urban Safety	Insuffiecient night lighting							X	X					
		Risk of collapse of negleted historic buildings													
	Heritage	Abandonment of historic center						X	X	X		X			
	Awareness	Accessibility					X								
		Recycling													X
		Cultural Heritage						X							
	Accessibility	Lack of ramps					X								
		Lack of visually impaired paths					X								
	Nuisance	Exhaust odour	X	X	X							X			
Economic	Tourism	Unfunctionized and inactive of historic center						X	X						
	Local Economy	Insufficiency of social services							X						
	Life Cycle Management of Urban Properties (Materials, Structures, Systems)	NONE													
	Idle Buildings	Unfunctionized and inactive of historic center						X	X						

Figure 4. Description and sustainability proposals for the axis in Balıkesir by H. N. Selamet.

In Table 4, the specific sustainable solutions for the selected axis are classified in different areas: solutions about mobility issues are increasement of pedestrianly movement-based transportation, implementing a bicycle path to the existing road, increasement of traffic signs to prevent accidents, underground parking lots that ground levels are designed as open green public areas and encouraging electrical cars from macro scale by adding battery units on the axis. Integration of ramps and visually impaired paths are designed for the entrances of buildings, pedestrian paths and crossovers. In order to improve green areas, afforestation on the axis and transformation of idle open areas and car parking areas to green public spaces are designed. Also, these green areas are considered as earthquake assembly area. Restoration, renovation and refunctioning the abandonment historical area are designed. Transforming the axis into a culture street with small exhibition areas, bookshops, cafes and performing areas are planned. Also, night lightning system based on solar energy is assigned into the whole axis which will improve urban environmental comfort and urban safety. Placement of recycle boxes for each 400 m is planned.

3.4. Bursa

Bursa is a city in north western Turkey; with population more than 3 million people the fourth-most populous city in Turkey and second-most populous in the Marmara Region. The historical background of the city starts from 5200 BC and it is second capital city of Ottoman Empire, standing on the north western slopes of Mount Uludağ which is named as Mysian Olympus in classical times and nowadays it is important for winter tourism and sports [16]. It has seacoast the Marmara Sea. The city has hot, dry summers that last for three months and winters are cold and damp, also containing the most rainfall. The city is called 'green Bursa' in daily life in refer to its large green areas; even though today there is a decrease due to the excessive urbanization. Bursa is one of the industrial centers of the country as most of Turkey's automotive production takes place in Bursa. Air pollution is a chronic problem in Bursa as results of containing numerous industrial areas.

The selected axis is Altıparmak Street in historic center of Bursa. The axis starts from Veldei Palace Mosque and ends in Ahmet Vefik Paşa Theater. The axis is 1100 m long and along with it, there are historic Hans from Ottoman Empire, Gazi Orhan Bey Mosque and Ulu Mosque dated back from 14th century, the Clock Tower from 1900s, old central bank building from 1967 and new shopping mall buildings.

Bursa is also located in the 1st degree earthquake zone which makes important in designing and planning phase. The specific sustainability problems about the axis that defined in this study and shown in Table 5. There are numerous important problems about mobility: high density of vehicle traffic causes excessive amount of exhaust gas, problematic tram network as being so slow and interrupting the public transportation traffic flow, lack of bicycle road, insufficiency of traffic lights and bus stops, mislocation of bus stops, excessive crowd on open air steep 25 meters escalator which leads to Saltanat Kapısı. Also, there is an idle and unemployed underground pedestrian subway which people usually do not prefer to use. Along the axis, there is no standardization on signboards, HVAC external units and TV satellite dishes on the facades which ends up in visual pollution. There is no recycle boxes along the axis. In the meantime, accessibility conditions about visually impaired paths are missing. Another important issue about this axis is idle buildings in historic center: the Hans Area which began its economic development in the 14th century in Ottoman Empire. Finally, there are damages on existing green areas to continue urbanization.

Table 6. Sustainability related problems – solution

BURSA: THE AXIS ON ALTIPARMAK STREET			SUSTAINABILITY SOLUTIONS																
SUSTAINABILITY ASPECTS	URBAN SUSTAINABILITY INDICATORS	SUSTAINABILITY PROBLEMS	Increasement of pedestrianial movement based transportation.	Implementing crossovers and traffic light at some points on the axis	Relocation of existing bus stops	Moving the existing tram network to a parallel street.	Implementing a bicycle path to the existing road.	Encouraging electrical cars from macro scale.	Integration of visually impaired paths.	To limit and control the number of people using the escalator	Restoration, renovation and refunctioning the abandonment area.	Assigning social functions like cafes, bufes, galleries for the Hans and underpass	Increasement of lighting based on solar energy in the underpass	Mesh panel systems for HVAC external units.	Afforestation on the axis.	Transformation of idle open areas to green public spaces.	Preservation of existing green areas.	Placement of recycle boxes for each 400 m.
Environmental	Green spaces	Damage to the existing green areas													X	X	X	
	Energy efficiency	Heat Island affect													X	X	X	
	Mobility	Pedestrian circulation problems	X	X	X	X	X											
		High density of vehicle traffic	X	X	X	X	X											
		Problematic tram network causing conflicts in traffic flow				X												
		Mislocation of bus stops			X													
	Air Quality	Excessive amount of exhaust gas.	X				X	X										
	Waste / Reuse / Recycle	Insufficiency of trash boxes and lack of recycle boxes.																X
	Disaster Management	Insufficiency of earthquake and disaster assembly areas.														X	X	
Social	Quality Public Space	Lack of quality open public spaces.									X					X		
	Urban Safety	Unsafe conditions of pedestrian paths /overpass/underpass		X								X	X					
		Excessive crowd on open air steep 25 meters escalator								X								
	Heritage	Idle buildings in historic center: the Hans Area									X	X						
	Awareness	Accessibility							X									
		Recycling																X
		Protection of public green areas															X	
		Cultural Heritage									X	X						
	Accessibility	Lack of visually impaired paths							X									
	Nuisance	High level of noise	X				X								X		X	
		Visual pollution (unplastered facades, AC units, signs..)												X	X			
		Exhaust odour	X				X	X							X			
	Tourism	Unfunctionized and inactive of historic center									X	X						
	Local Economy	Insufficiency of social services									X	X						
Economic	Life Cycle Management of Urban Properties (Materials, Structures, Systems)	Need of redesigning for the bus stops in terms of climate conditions			X												X	
	Idle Buildings	Unfunctionized and inactive of historic center									X	X						

The specific sustainable solutions for the selected axis are classified in different areas: solutions about mobility issues are increasement of pedestrianly movement based transportation, implementing crossovers and traffic lights on the axis, moving the existing tram network to a parallel street, implementing a bicycle path to the existing road, relocation of bus stops, increasement of traffic signs to prevent accidents and excessive usage of car horn, underground parking lots that ground levels are designed as open green public areas and encouraging electrical cars from macro scale by adding battery units in gas station on the axis.

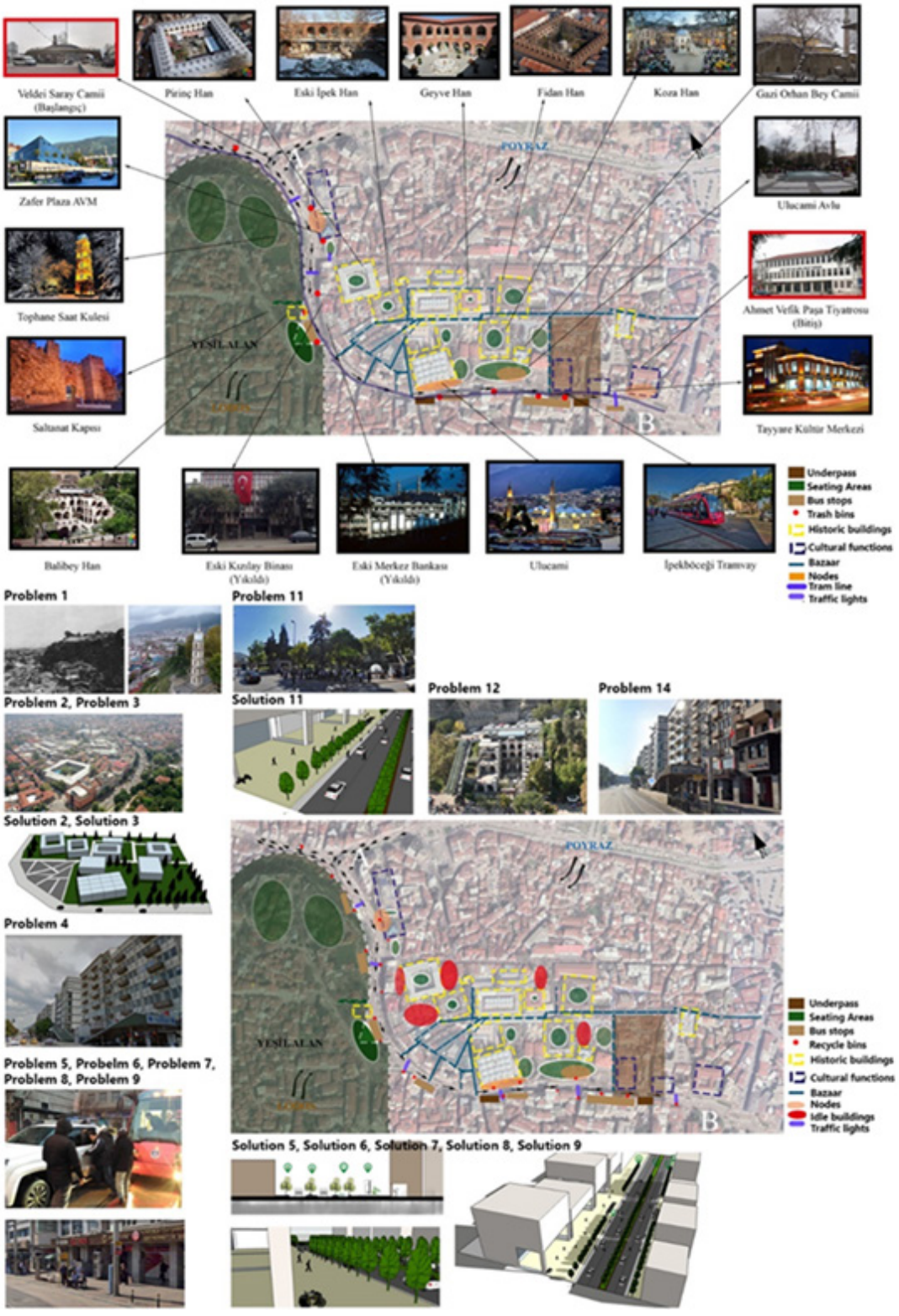

Figure 5. Description and sustainability proposals for the axis in Bursa by M. Bakan.

In addition, reconsideration of a new milder steep escalator system by arranging at different levels which includes landings is important for urban safety and connectivity. Integration of visually impaired paths is designed for the entrances of buildings, pedestrian paths and crossovers. In order to obtain green areas; afforestation on the axis, transformation of idle open areas and car parking areas to green public spaces and protection of existing green areas are planned. Also, this large green area is considered as earthquake and disaster assembly area. Transforming unemployed underground pass into a small-scale bazaar to improve local economy and solar panel-based lighting system to the underground pass are designed to have safer urban environment. Standardization about advertisement signboards and mesh panel systems for HVAC external units are proposed to solve visual pollution. For the continuity of cultural heritage; restoration, renovation and refunctioning the abandonment historical Hans area are planned which aims to transform Hans area into a cultural Han district with small exhibition areas, bookshops, cafes and performing areas. Placement of recycle boxes for each 400 m is planned.

3.5. Adıyaman

Adıyaman is a city in south eastern Turkey from 40,000 BC in bronze ages. Till Greco-Iranian Commagene kingdom was founded in 69BC [17]. The main economic activities are agriculture and tourism that is depended on Nemrut. In Adıyaman summers are very hot and very dry; winters are cool to cold with heavy precipitation. Due to its inland location and relatively high altitude, frost and snow are common. Major environmental problems are infrastructure, unplanned urbanization, insufficient landscaping, scarcity of green areas and air pollution in winter throughout the whole city [18].

Table 7. Sustainability related problems – solution matrix for Adıyaman (Compiled by authors).

			SUSTAINABILITY SOLUTIONS															
ADIYAMAN: THE AXIS ON ATATURK BOULEVARD			Increasement of pedestrianial movement based transportation	Implementing a bicycle path to the existing road.	Encouraging electrical cars from macro scale	Underground parking lots	Integration of ramps and visually impaired paths.	Defining a proper function for the unfinished building	Completion of the unfinished construction work with sustainable approach and materials.	Increasement of traffic signs	Assigning sound absorber façade panels on building's ground level.	Assigning environmental friendly external wall systems	Standardization about signboards	Mesh panel systems for HVAC external units	Limitations and standardization about exterior extensions of cafes and restaurants.	Afforestation on the axis	Transformation of idle open areas to green public spaces	Placement of recycle boxes for each 400m.
SUSTAINABILITY ASPECTS	URBAN SUSTAINABILITY INDICATORS	SUSTAINABILITY PROBLEMS																
Environmental	Green spaces	Lack of quality open public spaces.														X	X	
	Energy efficiency	Facades without plasters and finishing materials.									X	X						
		Heat Island affect														X	X	
	Mobility	Pedestrian circulation problems	X	X														
		High density of vehicle traffic	X	X	X													
		Lack / Insufficiency of parking areas				X												
	Air Quality	Excessive amount of exhaust gas.	X	X	X													
	Waste / Reuse / Recycle	Insufficiency of trash boxes and lack of recycle boxes.																X
	Disaster Management	Insufficiency of earthquake and disaster assembly areas.															X	
Social	Quality Public Space	Lack of quality open public spaces.															X	
		Invasion of pedestrian paths by exterior seating extensions of cafes													X			
	Urban Safety	Unsafe conditions of pedestrian paths / overpass / underpass							X	X								
	Heritage	NONE																
	Awareness	Accessibility					X											
		Recycling																X
	Accessibility	Lack of ramps					X											
		Lack of visually impaired paths					X											
	Nuisance	High level of noise								X	X					X		
		Visual pollution. (unplastered facades, AC units, signs...)										X	X	X	X			
		Exhaust odour	X	X	X											X		
	Tourism	NONE																
	Local Economy	Insufficiency of social services						X									X	
Economic	Life Cycle Management of Urban Properties (Materials, Structures, Systems)	NONE																
	Idle Buildings	Unfinished construction works and buildings						X	X									

Figure 6. Description and sustainability proposals for the axis in Adıyaman by Ş. Bozkurt.

The selected axis is located on Atatürk Boulevard in the center of Adıyaman. The axis starts from Clock Tower and ends in Atatürk Street Intersection. The selected axis is 440 m long and includes banks, shopping areas and offices. It is a route for bus and minibus public transportation types.

As Adıyaman is located in the 1st-degree earthquake zone; the lack of earthquake assembly areas is one of the main problems on the axis. The specific sustainability problems about the axis defined in this study and are shown in Table 6. There are problems in mobility: high density of vehicle traffic, an excessive amount of exhaust gas results in decreasing air quality, insufficiency of parking areas, lack of bicycle roads and accessibility problems about missing ramps and visually impaired paths. Due to the high density of traffic, there is a nuisance of a high level of noise. Along the axis, there is no standardization on signboards, HVAC external units and TV satellite dishes on the facades which ends up in visual pollution. There are not enough open green areas. The main functions along the axis are based on trading and there are so many cafes and restaurants. There is an invasion of pedestrian paths by exterior seating extensions of cafes and restaurants. There are no recycle boxes to maintain lifecycle management. In the meantime, there is an idle building that has unfinished construction works causes urban safety problems as well as visual pollution.

The specific sustainable solutions for the selected axis are classified in different areas: solutions about mobility issues are increment of pedestrian movement-based transportation, implementing a bicycle path to the existing road, increment of traffic signs to prevent accidents, underground parking lots that ground levels are designed as open green public areas and encouraging electrical cars from macro-scale by adding battery units on the axis. Integration of ramps and visually impaired paths are designed for the entrances of buildings, pedestrian paths and crossovers. In order to improve green areas, afforestation on the axis and transformation of idle open areas and car parking areas to green public spaces are designed. Also, these green areas are considered as an earthquake assembly areas. Completion of the unfinished construction work with sustainable approach and materials and defining a proper function for the economy and social life of Adıyaman are planned. Also, a night lightening system based on solar energy is assigned to the whole axis which will improve urban environmental comfort and urban safety. Limitations and standardization about exterior extensions of cafes and restaurants are planned. Standardization about signboards and mesh panel systems for HVAC external units are proposed for the facades of buildings on the axis. Placement of recycling boxes for every 400 m is planned.

4. DISCUSSION

In this study, five different cities which are differentiated at HDI rankings and Forbes livability index were evaluated. Then, sustainability problems that were related to selected axes were defined. In this regard, European Commission's Science for Environment Policy was examined in detail and a new evaluation criterion with urban sustainability indicators in order to investigate environmental, social and economic sustainability were proposed.

In order to improve the sustainability of the axis, major urban sustainability indicators were defined with consideration of frequency and quantity of problems related to the indicator. The major eight indicators were mobility, urban safety, the existence of idle buildings, quality of open spaces, nuisance, recycling, green spaces and accessibility.

The urban metabolism framework has been created as a spider diagram in Figure 7. It shows the existing situation with a simple representation technique and a tool to understand and classify main problems easily as well as facilitating the linkage between the environment and economy [19, 20]. Spider diagram compares urban dynamics to organize data in a logical way as well as being a visual tool. This spider diagram framework shows the comparisons of existing sustainability urban situations of the axes on major eight sustainability indicators that are selected in this study. The levels of problems from 0 to 3 are classified according to quantity and quality of sub-problems from Table 3, Table 4, Table 5, Table 6, Table 7. Therefore, the spider diagram has been formed as in Figure 7.

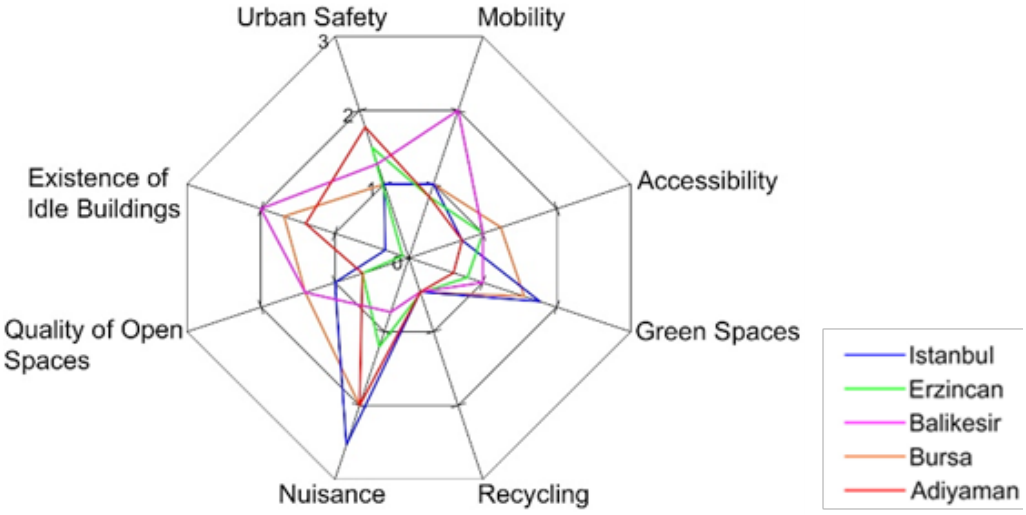

Figure 7. The Urban Metabolism Framework. The Urban Metabolism Framework was tested on five representative cities: İstanbul, Erzincan, Balıkesir, Bursa and Adıyaman (Drawn by authors).

As it is obvious in Figure 7, there is an urgent necessity to solve recycling and accessibility problems rapidly as their levels are the lowest in all five axes. Also, these problems can be solved relatively easily by the involvement of local authorities. In addition, public awareness has to increase; as the most important thing is not placing recycle boxes; but providing public to use them efficiently. Enlarging the green spaces are not only improves environmental conditions but also acts as disaster assembly areas.

Particularly for the whole five axes, existing earthquake assembly areas are not sufficient. According to Japan International Cooperation Agency (JICA), the gross minimum area of the assembly areas for the population living in that region is determined as 2 m2/person for the 1st-degree earthquake zones [21]. For the whole axes, this calculation should be done and aimed to be obtained this safe level. Moreover, nowadays as a result of the coronavirus pandemic; the necessity of quality of open public spaces is increased. While proposing sustainable urban models for axes, current coronavirus requirements should be taken into consideration.

5. CONCLUSION

As highlighted in the UN's report, today the Earth and all the livings are encountering immense challenges to sustainable development. Climate change, disasters, pandemics are real; there is no other option to think and imply sustainable solutions starting from the very micro scale. In this study, it is emphasized that thinking on a macro-scale while designing in micro is crucial. With an aim of having sustainable cities by 2030; five different city center axes were studied in this study as a starting point. Sustainable transformations on axes should be considered as parts of the whole world.

The objectives of this study are to measure and define the existing conditions of selected five different axes from Turkey in terms of urban sustainability from environmental, social and economic perspectives; and to sustainability transformation model on an urban scale. These five axes are examined according to urban sustainability indicators and solutions are generated via 2D&3D presentations and tables.

One of the main key findings of this study is; all five axes have limited sustainability features in terms of urban areas. Although, there is an insight about accessibility, there are misapplications and improper solutions in all city axes. Besides, there is a huge need for green areas as green areas are the main public recreation areas and disaster assembly areas. In addition, vehicle parking areas are problematic issues that are directly related to over-urbanization and the heat-island effect. Moreover, there are some obstacles in walkability as discontinuity of pedestrian axes exists.

Implications of the study can be listed as:

-Think in macro, design in micro

-Increase in sustainability awareness of public

-Protection of existing green areas and extension green areas

-Necessity of rearranging transportation system, considering the urban sustainability indicators

-Implication of sustainability plans as soon as possible by local authorities and government agencies

-Covering sustainability subjects in architecture education in various courses.

For further studies, this model should be considered as a prototype that can adapt to similar urban areas; not only for city centers but also all around the city. For future studies, this study should be considered as a guideline about sustainable transformations about axes in the urban context, and aimed to be a resource for government and local authorities. In addition, local authorities could use the urban sustainability indicators to obtain the problems and solutions rapidly.

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Researching for Methods in Visual Analyses of Urban Skylines

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Abstract: *Urban skylines are important components of a city's morphology and are an area of interest for urban design. There are various research areas on urban skylines like protection of historical urban skylines, facade analyses, future models on urban three-dimensional appearances, high building policies and view management. Urban skylines also provide the best visual representations to observe the phenomenon of urban transformation and change. The aim of this study is to form a basis for a multi-component urban skyline aesthetics assessment model that includes formal and socio-psychological dimensions by grouping the methodologies of studies on urban skylines. The information of the urban skyline analyzes developed by the author selected from different countries formed the basis for the study model. Among the methods to be covered, there are approaches such as GIS techniques, aesthetic evaluation with information entropy, fractal geometry, and cognitive studies for urban skylines. The research approach includes the examination and evaluation of applied studies of this area based on literature.*

Keywords: *Urban design, urban skylines, urban aesthetics, skyline evaluation, research methods.*

Kent Siluetlerinin Görsel Analizinde Yöntem Araştırması

Öz***:*** *Kent siluetleri, kent morfolojisinin önemli bileşenleri arasındadır ve kentsel tasarımın ilgi alanıdır. Tarihi kent siluetinin korunması, cephe analizleri, kentsel üç boyutlu görünümler üzerinden gelecek modelleri, yüksek yapı politikaları ve görünüm yönetimi gibi kent siluetleri üzerine çeşitli araştırma alanları bulunmaktadır. Kent siluetleri, kentsel dönüşüm ve değişim olgusunu gözlemleyebilmek için en iyi görsel temsilleri sağlar. Bu çalışmanın amacı, kent siluetlerinin estetik değerleri üzerine araştırma yöntemlerini gruplandırarak, biçimsel ve sosyo-psikolojik boyutları içeren çok bileşenli bir kent silueti değerlendirme modelinin kurgulanması için bir temel oluşturmaktır. Farklı ülkelerden seçilmiş yazar tarafından geliştirilmiş siluet analizlerinin bilgileri çalışma modeli için altyapı oluşturmuştur. Ele alınan yöntemler arasında CBS teknikleri, enformasyon entropisi ile estetik değerlendirme, fraktal geometri ve kentsel siluet için bilişsel çalışmalar gibi yaklaşımlar bulunmaktadır. Araştırma yaklaşımı, konuya ilişkin uygulamalı çalışmaların literatüre dayalı olarak incelenmesini ve değerlendirilmesini içermektedir.*

Anahtar Kelimeler: *Kentsel tasarım, kent silueti, kent estetiği, siluet değerlendirmesi, araştırma yöntemleri.*

1. INTRODUCTION

Urban skylines are the images that remain in the memory of people in interaction with the city. When it is asked about what a city looks like, postcard images often come to mind. While the building texture and facades are important for the architects, urban planners try to understand what the city looks like morphologically. In most cities such as Istanbul's Historical Peninsula, the coastal skylines, which have been conserved to a very limited extent, show the image of a very limited area. But when someone views the image from the skyscrapers, one can see what the city looks like. Figure 1 shows what people want to see when Istanbul is mentioned and Figure 2 shows what the actual shape of Istanbul now looks like. When these two photos are examined the risk of the Istanbul morphology is clearly seen. Various countries such as London apply view management to protect certain historic facade features and coastal views [1]. Most historical cities in Europe, on the other hand, have conserved their historical urban skylines by not constructing new buildings in their historical areas, like Amsterdam and Venice. These skylines can be likened heartbeat of cities or urban cardiograms. Figure 3 shows these regular and irregular urban cardiograms of the city with a metaphoric concept. Different approaches have been developed in sociological, morphological, computer-aided, architectural urban design and environmental psychology scales for the protection of historical urban skylines. Historic cities, especially the river fronts or sea sides reflect their aesthetic characteristics as a skyline image of the urban characteristics as a whole. If a few locations from the same coastal area are selected and photographed every year in metropolises such as Istanbul, the degree of change can be observed. Keeping this change under control depends on aesthetic controls and future simulations. Thus, an opportunity can be found to intervene before architectural projects are applied. At the same time, sharing possible future scenarios with the public can help raise awareness and public support in these areas. Along with the urban image, skylines are important for urban identity.

Urban skylines are a useful analysis scale as an indicator in assessing urban aesthetics and identifying problems related to high-rise policies. The aesthetic value of urban skylines is revealed through sketches, photographs, drawing programs and GIS models. In this field, there are various evaluation methods such as visual-based social media posts, surveys, cognitive studies, mathematical models, computer-aided simulations. This study aims to create a base for a multi-component urban skyline assessment model that includes formal and socio-psychological dimensions by grouping the methodologies of studies on urban skylines. Based on the literature background and previous applications of the author, this research aims to determine the interaction of different methods in the aesthetic evaluation of urban skylines. As a result, all analysis methods are useful tools for protecting historical urban skylines. And also, they point out that the buildings to be built in newly developing cities should be shaped by the design criteria. However, the important thing in this process is to be able to influence city managers on these issues while making decisions and orient them to create a public opinion to contribute to the protection of urban skylines and the improvement of their aesthetic qualities. Facade analysis in architectural studies and interface studies related to facade groups in urban space are also very diverse. This study, as an urban design scale, discussed the methods related to urban skyline scale as seen in Figure 1.

Figure 1. Historical Peninsula of Istanbul (Photograph taken by Author)

Methodologies in architectural facade studies have been excluded in this study. High building policies and legal regulations of the countries are excluded from the scope of this study. Innovative approaches on the aesthetics of urban skylines are considered.

Figure 2. Chaotic view from Istanbul European Side (Photograph taken by Author)

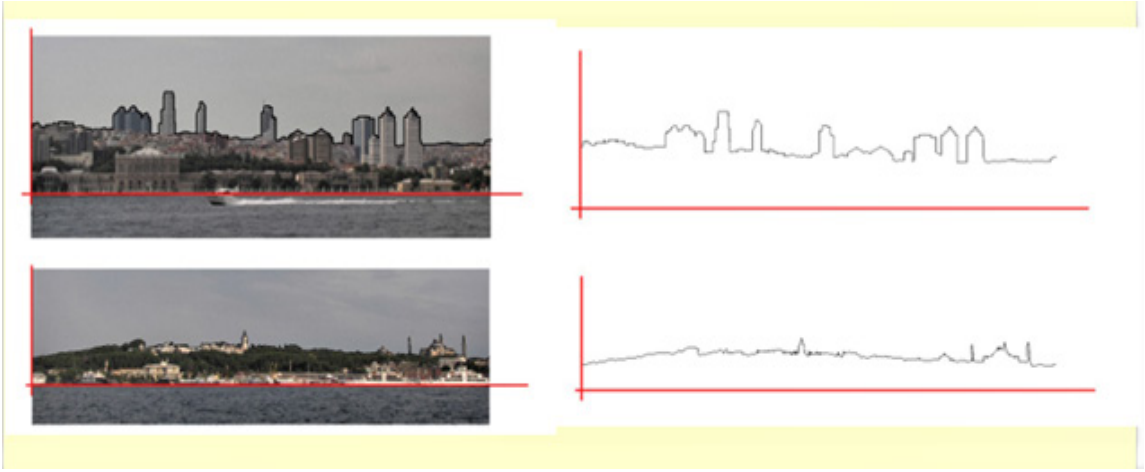

Figure 3. Urban Cardiograms of Istanbul Skyline (Developed by Author)

2. THE CLASSIFICATION FOR ANALYSES OF AESTHETICS OF URBAN SKYLINES

Since the study examines the analysis methods of urban skylines structurally, it includes the research methods in this area. Urban skylines are one of the main application areas in urban design. The aesthetic quality of the elements represents the city as being pleasant or unpleasant for the citizens in the evaluation of the city image. From the scale of the street facade to the scale of the urban skyline, the holistic effect, form

elements and visual harmony constitute the issues that gain importance in aesthetic evaluation. Urban skylines provide a broader combination of architectural, facade and interface evaluations. Within this wholeness, studies are examining both the relations with the sensory space perception and the numerical formal aesthetic criteria for urban skylines. The approaches are combining these researches and applying methods for testing each other. In this study, the methods applied for the aesthetic evaluation of urban skylines have been selected and examined. The author has current studies in these application areas and tested more than fifty skylines from different cities. From these applications, an integrated model has been created.

The research subject of the study includes examining the methods related to the urban skylines. Brief descriptions for the methods have been made. In most of the examples included in the review, different methods supporting the basic method are used together. Research methods in the study are collected under two headings. The descriptive methods reviewed in the first subtitle such as surveys, respondent's opinions, experimental studies. In the second title, some mathematical, statistical and computer-based studies for analyzing the aesthetic quality of urban skylines were examined.

2.1. Descriptive Studies for Analyzing Aesthetic Quality of Urban Skylines

The most common method for determining the aesthetic of an urban view like skyline is to show respondents various visuals and measure their pleasantness about them. A similar approach is done by walking around a research area with respondents and then taking their opinions about this area. In general, since the main goal of the design process is user satisfaction and appreciation, descriptive studies based on user opinions and experiences should be applied additionally to make a check-in different numerical methods. There are different applications in the fields of architecture and urban design, including subjective aesthetic evaluation techniques, mental evaluation techniques, multi-category evaluation techniques, mental estimation techniques, and comparison techniques [2]. In the subtitles of this section researches based on the participants he opinions of the respondents, including questionnaires and experimental studies, semantic differential approximations and cognitive studies on urban skylines have been reviewed.

2.1.1 Studies Made by Understanding Opinion of the Respondents for Urban Skylines

Generally, in aesthetic evaluation studies, city photographs are asked to be rated by respondents about their pleasantness. In these approaches, the participants can be directly asked to what extent they like the visual, as well as their opinions, are examined with experimental approaches and statistical techniques based on questionnaires. Lim and Heath (1994) used qualitative and quantitative data together in researching urban skylines and high-rise building relationships and included opinions of the participants in their studies [3]. For example, there is an urban skyline study carried out, which has been done on the examination of the visual effects of night appearance on people. "Digital colour photographs used on this study for comparing responses to skylines and natural scenes after dark, and skylines during the day. In the first experimental study fifty-nine respondents rate the pleasantness of each scene. They gave similar ratings to night skylines and natural scenes and rated each as more pleasant than the day skylines" [4]. Photo projective method (PPM) is an experimental aesthetic method in which visitors reflect their environmental connections and aesthetic concerns with photography [5, 6]. This approach can also provide a supportive contribution to skyline studies.

2.1.2 Semantic Differential for Urban Skyline Aesthetic Analyses

Semantic differential is used as a method that includes the ranking of concepts with their opposites in the evaluation of urban aesthetics. "Semantic differential is a method of approximating the effective value that an individual attribute to any phenomenon. This technique is presented in the form of a set of scales selected according to the degree of representativeness compared to the problem under study. Each of these scales is examined in groups that allow the tested person to show both the quality (positive or negative) and intensity of his/her reaction to the phenomenon in question" [7]. Semantic differential measures people's reflections and emotions by rating the scales with the contrasting adjectives [8]. Adjective pairs are used together with the semantic differential method. As an example of adjective pairs depending on aesthetic factors; contrasts such as pleasant/boring, different/habitual, meaningful/meaningless, interesting/not interesting and different/monotonous. Altuntaş and Önder (2016) used a semantic differential scale using adjective pairs for evaluating the urban skylines of Istanbul [9].

2.1.3 Cognitive Studies for Urban Skylines

Generally, in cognitive studies related to urban design, spatial motion and visual environment interactive issues come to mind like cognitive mapping and wayfinding. Cognitive mapping is a construct that encompasses the cognitive process that enables people to acquire, code, store, recall and manipulate information about the nature of the spatial environment. Figure 4 is an example of how the Istanbul Historic Peninsula skyline forms in the mind as a visual in memory. Bostancı and Oral (2017) made experimental research about what kind of a cognitive process is in the perception of urban skylines and how this kind of visual image formed in memory [10]. The aim of this study is to investigate how the image created by the skylines of historical cities can be expressed by drawing. The basic differences between the cognitive mapping techniques and the cognitive perception and the schematic display of a skyline can be discussed through this experimental approach. This study investigated the effects of cognitive features of urban skylines in the visual thinking system" [10]. This is a kind of experimental approach for the evaluation of urban skylines.

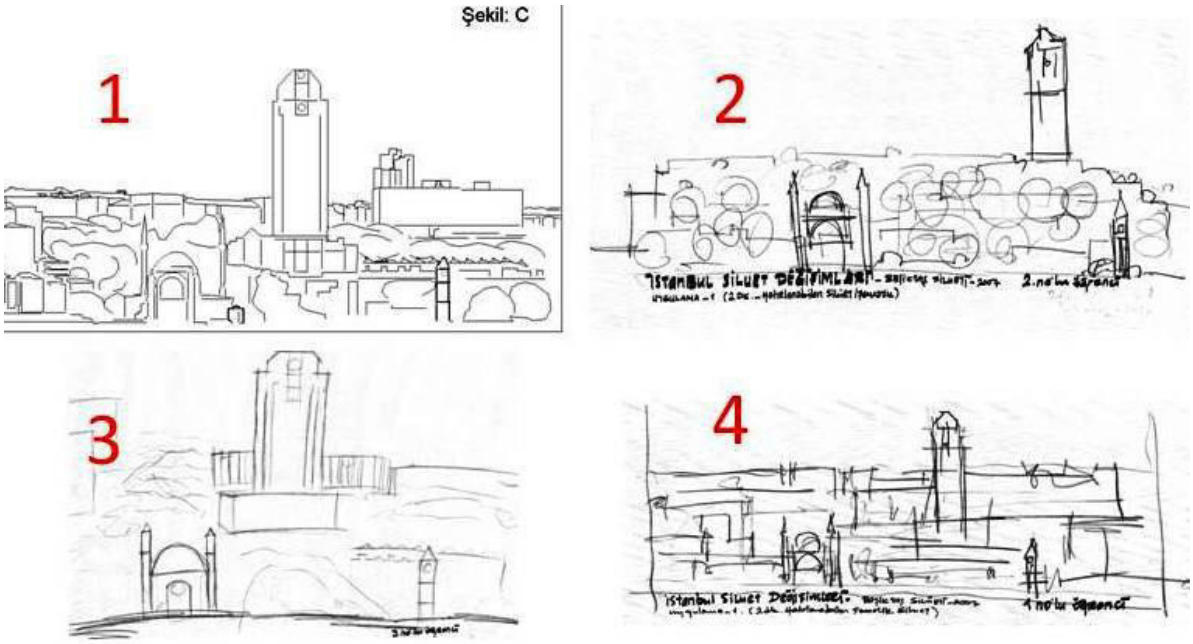

Figure 4. Urban Skyline Sketches [10]

Figure 4 is a part of experimental study made by Bostanci and Oral (2017) [10]. They show videos, skyline photos and skyline drawings to architectural students. And in Figure 4 the first sketch which is numbered as 1 is shown to the students. And 2-3-4 are the skyline sketches of the architectural students they draw what they remembered. These students are living in Konya and the image is from Istanbul. And these drawings show how the dominant structures are remembered as mental images.

There are also some methods depending on neuroaesthetics studies. These approaches are the cognitive neuroscience of aesthetic experience [11]. Neuroaesthetics is related to how the brain affects by the perception of beauty. This is a useful and innovative tool for understanding the human perception of urban skyline aesthetics. Choo et.al. (2017) is the first study that tries to measure how the visuals of special architectural structures create movement in the brain using brain imaging techniques. In this study, neural activity patterns associated with certain architectural styles were found in some high-level visual brain regions, but these effects could not be detected in the primary visual cortex [12]. Naghibi et.al. (2019) examined the effects of architectural features on the brain cortical system with imaging techniques, ERP signals and FMRI activation [13]. Architectural window shapes were found to have a significant effect on the modulation of cortical activity in this study. Similar approaches with these brain imaging techniques can also be carried out over urban skylines.

2.2. Mathematical and Computer Based Studies for Analyzing Aesthetic Quality of Urban Skylines

Today, developments in computer techniques have gone beyond the statistical analysis of questionnaires used in the aesthetic evaluation of urban skylines, and its scope has expanded to include the analysis of different equations on the city form. "Innovative techniques for the visualization and presentation of architecture and more efficient tools for planners and architects have evolved from the current progress in information technology and the improvements in computer hardware and software" [14]. In this section, information entropy, GIS-based approaches, space syntax and skyline analysis on fractal geometry will be examined.

2.2.1 Information Entropy for Evaluation of Urban Skylines

Entropy has two definitions within the fields of probability theory and thermodynamics laws together with statistics. This concept has been first of all used in thermodynamics laws. It has been Clausius (1822-1888) who had realized his studies by being inspired by Carnot's (1796-1832) thermal approach and set forth the name of entropy within the first law of thermodynamics. With relation to random processes, the logarithmic expression of Boltzmann (1844-1906) who have defined the statistical entropy and developed its formula is quite similar to today's information concept on basis of mathematical structure which has been known as communication theory developed by Shannon (1948) [15]. The main problem of communication is that the message selected at a certain point is reproduced approximately or completely at another point. The entropy approach is used in urban studies with various features. Figure 5 groups relevant urban research topics in this area [16].

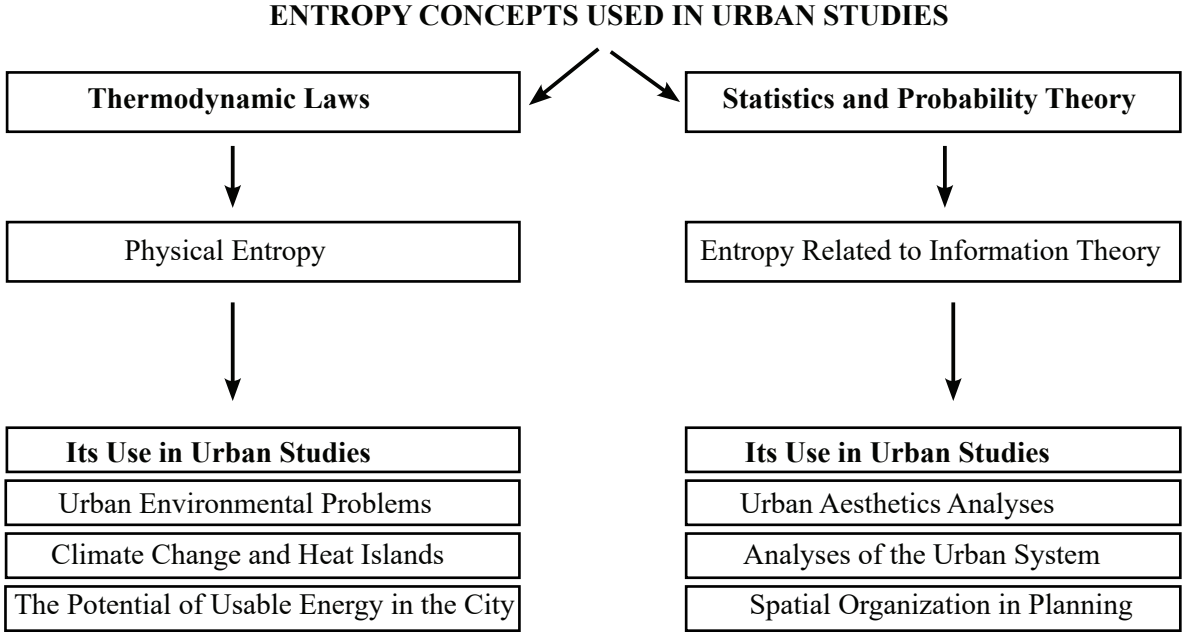

Figure 5. Using Entropy Concept in Urban Studies

The connection built between entropy and aesthetic has created the concept of information aesthetics [16]. Especially after it became an information criterion with its measurement value within the information theory developed by Shannon, entropy's area of usage has expanded. Consequently, entropy and information theory have been included among the concepts discussed in urban planning and urban development matters. The subject has been used in the visual evaluation and has started to be applied in architectural and urban design scales [17, 18]. Buttar et.al. (1973) have the first study for finding the aesthetic value of historical facades by the information entropy method. In urban design studies, its applications related to aesthetic evaluations of urban skylines are observed [17]. Stamps et.al. (2005) made researches on which building group affected in the cross-section of entropy approach and environmental psychology studies, for

editing urban skylines [19]. Salingaros (2000) made evaluations on the city, architecture and aesthetics using mathematical methods that include information entropy. He investigated the aesthetic appeal of simple textures using mathematical methods [20]. Information theory comprises the mathematical measurement of the information quantity of a message transmitted from a specific source, during the transmission process. Information theory can be approached as a branch of applied probability theory. By redefining entropy in information theory, Shannon has developed the mathematical structure of information theory. Alongside the measurements in the information theory on the aesthetic value of architectural and urban design measurements, Shannon's entropy formula is used [16, 21]. The use of entropy as a concept in different disciplines is also a subject that is criticized. [22]. There are criticisms regarding the use of entropy in the fields of architecture and design [23]. Within this approach, it is necessary to develop studies by considering critical approaches [24]. In such studies, the scope and limitation of the study should be clearly stated. These kinds of innovative approaches allow different interpretations of design contribute to the field.

2.2.2 GIS for Modelling Urban Skylines

GIS (Geographic Information System) is a computer-based system which is capable of integrating data from various sources [25]. This program is useful in urban planning and urban design as well as the other land based disciplines. "GIS techniques generated complementary insights about the spatial and non-spatial factors influencing attitude towards urban areas" [26]. In addition to the production of urban smart maps, GIS-based techniques display buildings in the third dimension. Thus, three-dimensional images of cities such as google earth can be displayed together with their morphology. These techniques are applied with innovative approaches, especially in urban skyline studies on high buildings. Guney at.al. (2012) applied a geo-model in the GIS environment in the aesthetic evaluation of urban skylines. In this study, the Maslak Axis, where high-rise buildings of Istanbul are located, is modelled. And with the study predictions are made for height limitation in buildings for metropolises [27]. The working structure is suitable for testing the skyline effects of future projects. Akdağ and Bostanci (2013) made aesthetic assessment measurement with information entropy over Istanbul skylines modelled with a GIS-based approach [28]. Thus, GIS-based modelling and entropy approach were taken together in the evaluation of urban skylines.

2.2.3 Space Syntax Analyses for Urban Skylines

Space syntax, which is among the objective methods considered in the aesthetic evaluation of the city, is an interactive approach that determines the relationships between external influences that produce forms and social forces [29]. "Space syntax is a research program that investigates the relationship between human societies and space from the perspective of a general theory of the structure of inhabited space in all its diverse forms: buildings, settlements, cities, or even landscapes" [30]. Space syntax, which is among the objective methods considered in the aesthetic evaluation of the city, is an interactive approach that determines the relationships between external influences that produce forms and social forces. "According to the findings of the researches on the subject, it has been determined that the spatial formation alone explains a significant proportion of the change in the total human movement values in different locations in the urban and building interior areas" [31]. When space syntax is associated with different cognitive techniques, it can provide various information on the effects of urban configuration on social life [32]. This method is very useful in pedestrian-friendly urban design studies [33]. Space syntax logic can be used in the current view of the city and also future prediction view of the city [34]. Space syntax studies have been applied in historical areas of Istanbul [35]. Space syntax is also applied to urban GIS studies [36]. Although this study is developed on the interaction with space, it may allow making a certain evaluation on the effects of the urban skylines. Space syntax is basically about citizen mobility experience. For this reason, this method is not very useful in evaluating urban skylines, which are static visual images like photographic views. However, this method can be used as an auxiliary tool in the analysis of the spatial relations of the facades in the evaluation of urban skylines.

2.2.4 Fractal Geometry for Urban Skylines

The foundations of fractal geometry were laid by Mandelbrot in the 1970s. Fractal geometry is different from classical geometry or Euclid [37]. "Fractal shapes are the patterns that are unique to them, repeating on scales from top to bottom so that parts of them at any scale resemble the whole in form. Mandelbrot exemplifies this self-likeness" feature by tearing a piece of cauliflower and points out that this piece itself looks exactly like a small cauliflower" [38]. Fractal geometry applications have recently been paid great

attention in ecology [39]. Fractal geometry is a special area of research in design fields [40]. Taylor (2006) made fractal calculations on the outer contours of urban skylines as a stress-reducing factor [41]. Various computer programs have been developed for fractal dimension measurements and model proposals. Among these, the HarFA program is used to measure the visual richness of images (photographs). HarFA: It means Compatible Fractal Image Analyzer. Visual data are measured according to fractal parameters and numerical values are obtained in fractal terms. With the help of this program, the "Historical Peninsula" coastal silhouette, which can be defined as the silhouette that reveals the historical identity of Istanbul, has been analyzed with this method in order to measure the visual richness of the urban skyline. In this process, the first taken photograph is converted to black and white form. Sharpness and image adjustment are done by the program. After these operations, the program shows the scatter plot and the value for the fractal dimension [42]. Various analyzes are made with fractal geometry in architectural facade evaluations and skyline analyzes [43]. These studies provide opportunities to comment on the visual change processes of cities. Fractal geometry calculates an image numerical value from visuals such as photographs. With this aspect, it calculates visual dimensions such as skyline. However, it cannot provide sufficient data for a holistic aesthetic evaluation based on separate data of design criteria. This method can be used as an auxiliary tool in evaluating the urban skylines.

3. INTEGRATION OF THE METHODS FOR URBAN SKYLINE ANALYSES

The research design of the study was formed by the ideas of the current studies seen in Table 1. This information also formed the basis for the groupings and the development of the model. From this point of view, this study is a synthesis of various researches carried out by the author in the period 2008-2019, in which more than fifty urban skylines are analyzed. An integrated model has been created by combining these methods for the evaluation of urban skylines.

Table 1. Ideas of the works carried out by the author that develops the infrastructure of the model.

Authors and Year	The Name of The Article	Explanation
Bostancı (2008)	Evaluation of the urban skylines by the entropy approach (Ph.D. Thesis)	The study, which analyzed 50 images in the aesthetic evaluation of city silhouettes, was carried out with the information entropy approach. This Ph.D. thesis also includes preliminary research knowledge of the methods explained in the study. In this respect, it forms the basis of the model.
Bostancı and Ocakçı (2011)	Innovative approach to aesthetic evaluation based on entropy	In the study, in which urban skylines were compared with Istanbul examples, information entropy-based analyses were made.
Akdağ and Bostanci (2013)	The Impacts of prestige projects on the skyline of Istanbul	This study has a unique content in which the GIS model and information entropy approach are integrated over the skylines of Istanbul. It provided an important input in the development of the model.
Bostanci, and Oral (2017)	Experimental approach on the cognitive perception of historical urban skyline	This study includes cognitive studies for urban skylines with an experimental approach. Semantic differential is used for testing the results.
Bostanci (2019)	Critical thinking about urban studies linked with thermodynamic terms	The approach in this study, which includes criticisms of numerical studies such as information entropy, contributed to the creation of the details of the model, especially in the selection of the image to be analyzed.

Table 1 provided data for the formation of the model developed in this study. Figure 6 shows the model developed by this study.

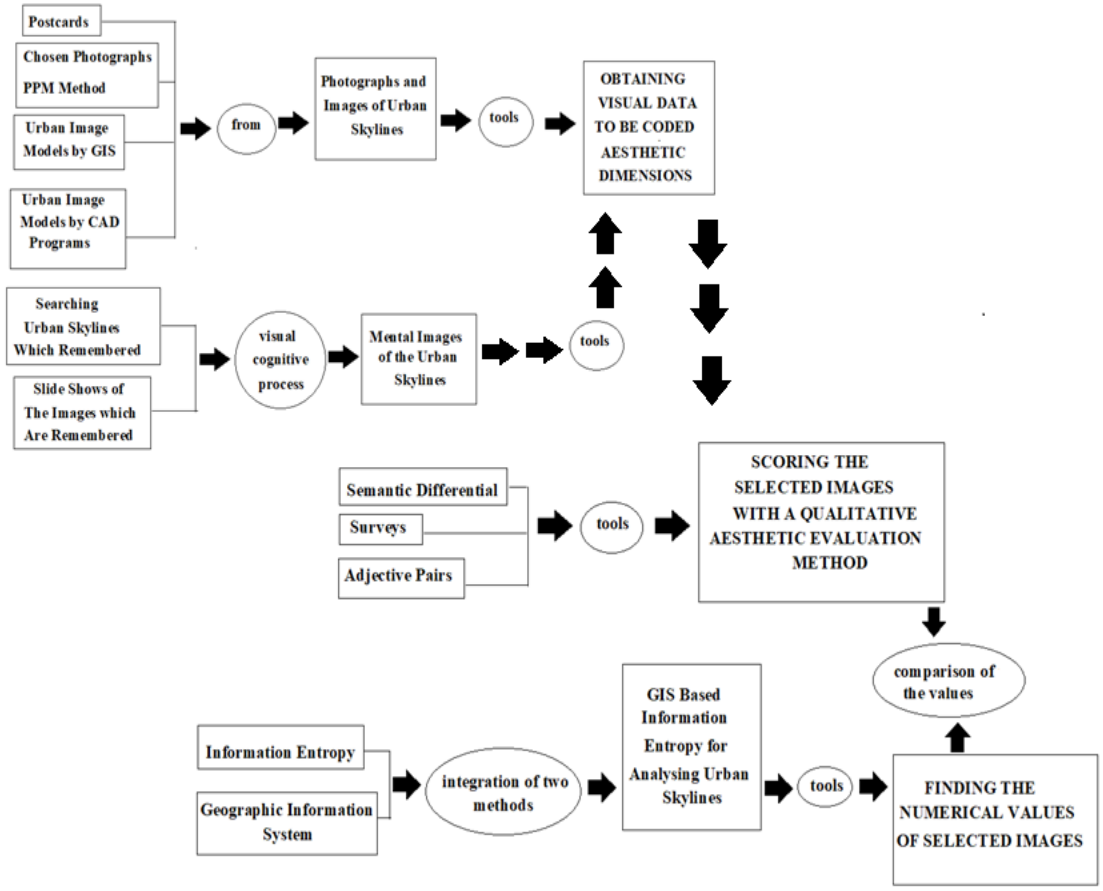

Figure 6. Integrated Aesthetic Evaluation Model for Urban Skyline Analyses (Drawn by Author).

The model seen in Figure 6 can be applied over two different areas in urban design. One of these fields is formal aesthetic evaluation, and the other is environmental psychology. The distinction between them shows two separate paths to the "obtaining visual data to be codded aesthetic dimensions. The acquisition of images with photography and computer techniques makes the study a subject of formal aesthetic evaluation. Here, visual data are obtained in four ways. These are photographs taken with PPM method, postcards, modelling urban images with computer based visualizing programs like GIS and CAD programs. In this way, visual data obtained in more objective ways obtain aesthetic value with the entropy method of GIS based information, and these values are tested by comparing them with the scoring in qualitative methods in the model.

If an urban skyline assessment is to be made on environmental psychology, the visual perception and cognitive process of the observer should be monitored. At this stage, the second way is applied in the production of visual data. Here, visual data is obtained by drawing a skyline image remembered by the participants. Thus, some of them are obtained by showing them visually and drawing what they remember or some of them are obtained by asking them to draw the skyline that they remembered in the city they live in. Since this kind of visual data also requires the ability to draw, it is more appropriate for students from architecture faculties to be participants in this experimental study. Nevertheless, if a control group far from the design areas contribute to the experiment, some information about the most remembered buildings of the city can be obtained. A detailed applied research on this subject can be seen in the study of Bostanci and Oral (2017)

[10]. Again, with this approach, visual data is obtained through sketches. And this data is processed with GIS-based information entropy method for its numerical aesthetic value. The aesthetic value data in bits obtained from the findings can be compared with scoring in qualitative methods.

4. CONCLUSION

In this study, an approach that evaluates the aesthetics of skylines in the context of urban design has been developed. There are different descriptive and applied studies in urban conservation and urban history and urban identity studies. The skyline evaluations can be added to these studies. Interdisciplinary approaches can increase the scientific depth of these studies. Urban skylines provide various information about the historical background of the cities, their political understanding, cultural texture, their position in the global system, their economic potential, belief systems, and their sociological characteristics. Thus, there are various topics that can be explored for researchers interested with urban skylines.

The studies examining the urban skylines throughout this research, many publications dealing with Istanbul were encountered. Skylines of Istanbul offers researchers a wide variety of visual boards such as historical panoramas, mass housing areas, chaotic topography and high-rise buildings showing the global vision of the metropolis. Depicting what remains in his mind as a result of examining a city from a helicopter with her panoramic memory, Stephen Wiltshire also chose Istanbul in this field of study [44]. Some new subjects will also bring approaches to skyline studies in the near future such as how people handle urban skylines as social media sharing images and which skylines are scanned more in computer searches.

As a result of this study, a unique urban skyline aesthetic evaluation model shown in Figure 6 has been obtained. This model is also a synthesis of the studies shown in Table 1. This model can be developed in future studies with different data processing methods such as machine learning and big data. However, all these methods can be considered as intermediate methods in finding the aesthetic values of urban skylines in terms of bits using information entropy method. This study suggested information entropy as a unifying method for urban skylines. Although some of studies seen in Table 1 are used images from different cities, the author has included Istanbul skylines in her all these works. The common point of these studies is that they emphasize the importance of preserving the Historical Peninsula, which is the unique skyline for Istanbul. From the first study of Buttar et.al. (1973) to Bostancı (2008) information entropy method highlights that the historical urban skylines are more valuable than modernist and high rise buildings in their aesthetic qualities. Because historical facades of the skylines have more visual information than modernist building facades.

In the field of urban design, new approaches and methods that can develop creative perspectives are sought. In this quest, computer sciences, physics, environmental psychology, sociology and many other fields are examined for new approaches by establishing connections with urban design issues. Studies on urban skylines provide important information on the transformation processes of cities. In this process, various drawbacks of applying and interpreting methods created by using the fields of engineering sciences and physics in urban design may arise. Generally, as discussed here in method processes, numerical models of a visual scene can be produced with various techniques. How to interpret the obtained data is the hard part of these kinds of researches. For example, sometimes design elements and their features can be defined by metaphors. However, this uncertainty can be resolved by the joint discussions of experts in the fields of science and design, as it allows more interdisciplinary studies today. But experts in technical sciences, especially engineering, are not willing to participate in studies in these fields of art and architecture. They may worry that their scientific stance will be questioned. This situation varies by country. For this reason, a situation may arise for designers to consult technical experts but not always work with them. Scientific achievements of interdisciplinary studies become more and more important every year, as long as they are not detached from their context and main purpose. One of the effects of these interdisciplinary studies is that the researches create an opportunity to attract more attention of the public.

This study has shown various approaches exist regarding urban skylines that can only be considered as the symbolic image of a city. Benefiting from the models mentioned here in order to protect the skylines in the historical and new development areas in the aesthetic boards of the municipalities can produce very effective results. So urban skyline effects evaluated and modelled for future constructions before a project is realized. This could be an opportunity for early intervention for protecting valuable urban skylines.

Such an integrated urban skyline evaluation model can help architecture faculty students to understand urban morphology in a different way. The model developed in this study (Figure 6) can contribute to urban design and architecture students' evaluation of urban aesthetics. So this it makes them thought about although some buildings have interesting designs, if they cannot establish the right relationships with the city's harmony, they cannot leave a good legacy for the city. It is important for the future of cities to be able to protect the skylines of historical cities in a holistic way. This important subject can be proposed as an elective course called "urban skylines" in architecture and urban planning education by improving its contents. At the same time, this method contributes to the pre-evaluation of professionals. Local governments can preserve the aesthetic values of their cities by taking advantage of this model.

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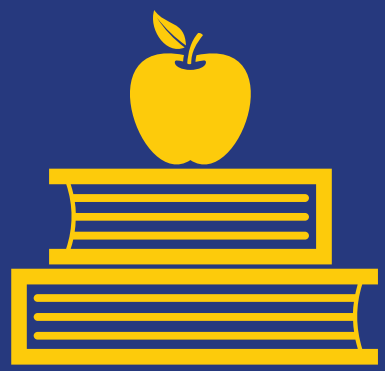

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