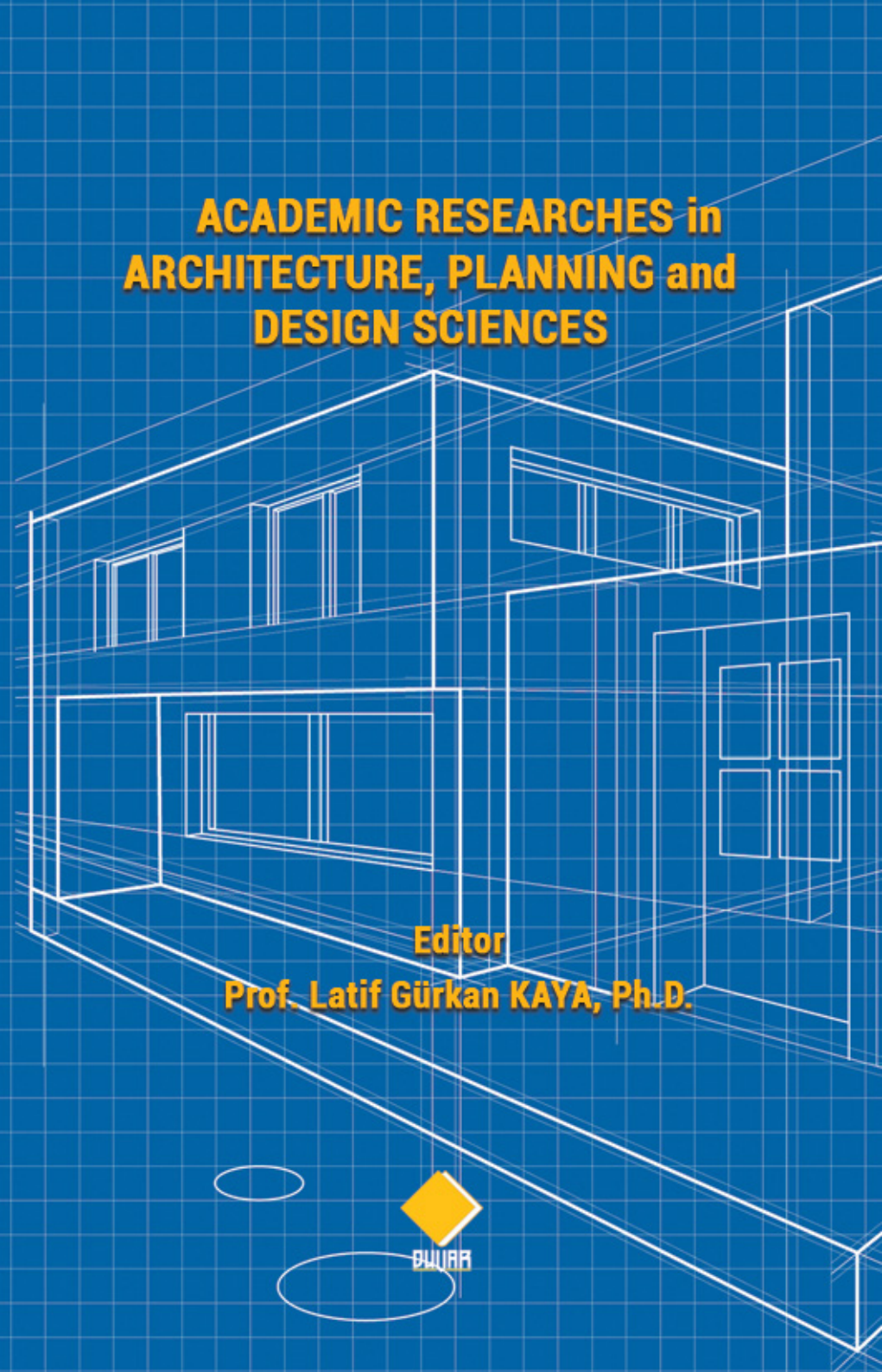
ACADEMIC RESEARCHES in ARCHITECTURE, PLANNING and DESIGN SCIENCES



Editor

Prof. Latif Gürkan KAYA, Ph.D.

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Chapter-1

A DETAILED NEW METHOD FOR VERNACULAR ARCHITECTURE RESEARCH PART I: INTRODUCTION AND INPUTS

Dr. Atlıhan Onat Karacalı

1. INTRODUCTION

Human build. There is a common misconception that man is not unique among other organisms in shelter construction. The main difference is that animals' nesting behavior refers to an instinct where human structures are results of deliberate design decisions taken to meet perceived needs. Whether the resulting structure is a hut, an igloo, or a teepee, the decision-making factors of the design process are a complex combination of elements. This study aims to analyze the elements affecting the vernacular architecture.

As far as we know, Earth is the only planet known to support life, thanks to its perfect distance to Sun, tilt in its axis, and quality of its atmosphere. These geographic features define various biomes with unique creatures evolutionary adapted. Human, on the other hand, is the only species of planet Earth who quickly spread all corners before biological adaptation completed. However, humans stand out for their incredible versatility. The cognitive revolution completed beforehand human cultures, which is the key to reshape the environment and domesticate themselves, even in the most severe conditions. Architecture is here accepted as the production of culture.

Distinct biomes support different sets of endemic lifeforms. Humans, the only pandemic creature, have this amazing ability to manipulate not only the inorganic environment but also these animals, plants, and fungi as well. Controlling the other creatures, mankind create economies. These climate-driven distinct economies can also be accepted as the man's reaction to his surroundings. Certain economies support certain forms of social organizations, which once again lead to the anthropologic definition of culture. And distinct economies, and cultures

as well, are going to need distinct spatial needs that architecture needed to solve.

In crowded and complex social organizations, designing and/or building of a structure is a well-defined profession. However, not all structures on the globe were designed by educated architects or illiterate craftsmen, on the contrary, their percentage is very few. In other words, 90 to 98 percent of the total building stock of the world has a vernacular identity[1]. The strict definition of vernacular architecture is basically 'architecture without the architect' where the expanded definition says 'related to environmental contexts, available resources, and traditional techniques, the vernacular architecture is built to meet specific needs, accommodating values, economies, and ways of living of the cultures produced them'[2].

Features mentioned up to this point, the climate, the economy, and the culture are accepted by this study as the abstract inputs of vernacular architecture. Though detailed briefly, all concepts mentioned here are already enough in the perception of human diversity, and from the architectural perspective, diversity of building typologies. From now on, the concrete outcomes of vernacular architecture, the material, the technique, and the form are going to be evaluated (Image 1).

As told before, distinct biomes have different qualities both in biologic and inorganic features. People, in basic need of physical shelters, must figure out the building material from what really is found around. Certain materials are chosen because of their ease to build, or insulating qualities, or even large quantity. Not all materials are handled the same way. Some are available to pile up, some are to stretch, and even some are to mold. Some techniques are invented to merge materials with

distinct qualities. And sometimes, different techniques can be applied to the same material. Finally, through the process of materials by techniques, the physical form of the vernacular structure is going to be erected. The form is an important feature of architecture, which is always subject to discussions. Once again, certain forms are decided for a reason, maybe for its surface area, or for construction technique, or even for the cosmological meaning.

This study aims to create a new method for vernacular architecture research by categorizing the examples over these abstract inputs and concrete outputs.

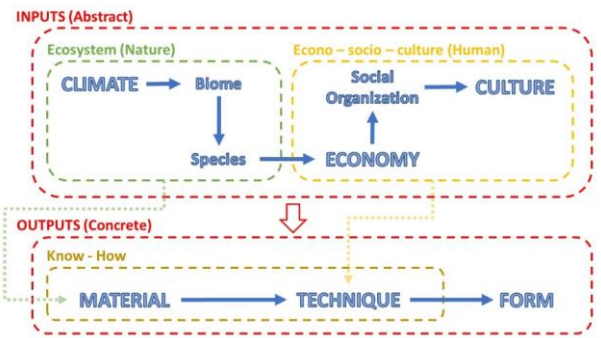

Image 1. Flowchart of the study

2. DEFINITION AND STUDY OF THE FIELD

It is difficult to define the vernacular architecture term. However, mentioning the characteristic parts of some of the well-known academic definitions here can be useful in understanding the scope of the term.

In *Encyclopedia of the Vernacular Architecture of the World* (EVAW), Paul Oliver says “related to their environmental contexts and available resources, they are

customarily owned or community built structures, utilizing traditional technologies", and "it includes the collective wisdom and experience of a society, and the norms that have become accepted by the group as being appropriate to its built environment"[3]. In another source, *Dwelling: The Vernacular House Worldwide*, Oliver also believes "it is the architecture of the people, by the people, but not for the people"[4]. In *Built to Meet Needs*¸ Amos Rapoport tells "all types of buildings made by people in the tribal, folk, peasant and popular societies whereas an architect, or special designer is not employed"[5]. And Nezar Alsayyad thinks "they were produced without the need for imported components and processes built by the individuals who occupy it"[6]. Also, according to Marcel Vellinga, the field is a "more dynamic approach that explicitly focuses on building traditions rather than buildings"[7]. In yet another definition, Dell Upton says "my preference is to define vernacular architecture not as a category into which some buildings may be fit and others not, but as an approach to architectural studies that complements more traditional architectural historical inquiries"[8]. Finally, it is extremely important to keep in mind that the Vernacular Architecture Forum (VAF) acknowledges that there have been and continue to be debates on defining vernacular architecture[9].

In order to construct this study's definition, first, it is going to be useful to evaluate what we have in hand. As the very first rule, no professional designer is going to be in charge, neither an architect nor a carpenter nor a bricklayer. Second, the needs of the local climate are going to be met. Third, the solution is going to work together with the local socio-economic and cultural identity. More, locally available material is going to be evaluated via traditional building techniques inherited from the ancestors. So, the

definition of vernacular architecture this study focuses on can be put forward as follows: "*the architectural activity presented in a geography, over locally available materials and experienced technique, collaborating with local climate and running the cultural values, however without the employment of a professional designer".* According to this study, vernacular architecture is valuable for its principles, not its form.

Though all these definitions, there still are common misconceptions about vernacular architecture. First, it was time to time misunderstood as if it was primitive architecture. However, they in fact outperform so-called modern structures even in the severest conditions. Second, another opinion that vernacular architecture is equivalent to ancient architecture is widespread. Though the building technique must be traditional, the vernacular structures have not solely existed in the past, they are still built and used at present. A third misconstruction puts forward the idea that vernacular architecture is limited to the rural world. As far as we know, during the beginning of the new millennium, half of the world's population lives in the cities and the other half is non-urban. It is obvious that the transformation and modernization process took place earlier in the developed settlements. Vernacular structures are less commonly spotted in cities, but they do exist as well. Each industrial city is an object of migration and has more or less suburban settlements, which are mostly constructed via vernacular principles. The last wrong perception accepts all vernacular structures as residences. Since housing is the only worldwide function among cultures, there is a vast variety to discuss within the study of the field. However, vernacular architecture is not confined to dwellings and it also includes outbuildings as

barns, byres, mills, granaries, also shrines, meeting places, shops, schools, bazaars, and more, only if they fit in the definition.

The history always was interested in the kings, empires and battles, and architectural history in palaces and temples. The folk tradition, the majority, was long accepted as too low-level to evaluate. However, it is the direct and unselfconscious translation into the physical form of a culture and its needs and values. Another feature of vernacular architecture about this disregard is its little reference to mainstream style or any prevalent theories of architecture. Until recent times, the vernacular architecture suffered from ignorance and indifference and left unrecognized and undocumented. However, the vast majority of people still live, work, and worship in vernacular buildings.

The last forty years have seen the academic study of vernacular architecture, still largely on the periphery of architectural history. The names mentioned above with their definitions and here are the pioneers. Bernard Rudolfsky's *Architecture without Architect* exhibition in 1964, Amos Rapoport's 1969 book *House Form and Culture*, Paul Oliver's 1969 book *Shelter and Society* and 1987 book *Dwellings: The House Across the World*, the famous *Encyclopedia of Vernacular Architecture of the World* edited by Paul Oliver in 1997 and its counterpart, *Atlas of Vernacular Architecture of the World* co-edited by Paul Oliver, Marcel Vellinga and Alexander Bridge in 2007 are the major works.

Vernacular architecture still needs to be studied in further details. The twenty-first century brings a new urgency to the study of vernacular architecture. Even the now-popular sustainability subject is a standalone enough

perspective and motivation for research. As mentioned before, the vast majority of the world's structures are in vernacular identity. Some of them were experienced in place over centuries or even millennia and reached perfection after countless trial-and-error, adjustments, and modifications. That means, the vernacular structures, as we know them today, are results of the cumulative experience of lineages. They are genuinely sustainable because they overcame so long time. More, with the rapid industrialization and urbanization of the Western world, there is a growing tendency to minimize or ignore the importance and complexity of the natural environment[10]. Popular idea offers that the Western building forms and technology are applicable in all climates and to all cultures. They obviously are not. Our era is one of the reduced physical constraints and we can do very much more than was possible in the past[11]. However, unfortunately, we act as if we have limited choices. Vernacular architecture can help us gain the understanding that we so desperately need.

On the other hand, the field must be studied in an interdisciplinary environment of geographers, historians, urban designers, interior designers, anthropologists, ethnographers, archaeologists, behavioral scientists, sociologists, conservationists, culturologists and even experts of local beliefs, joining the architects. Vernacular architecture can be misunderstood just as the concrete objects, as the materials brought together via techniques, unless those social sciences evaluate the abstract features behind the design decision.

Vernacular architecture can also be essential to the education of architects. The present so-called "primitive hut" studies are coined generally to the first year of education, whereas they should study vernacular

architecture in their final year. Hopefully, there are now courses and modules titled “vernacular architecture” in many world universities, and comparing with the previous times the value of the field is partially restored. Further studies must be provided for each distinct individual sector of the world. Because the vernacular architecture obviously does have a lot to teach.

3. INPUTS OF VERNACULAR ARCHITECTURE RESEARCH

As told above, this study counts climate, economy, and culture as successive abstract inputs of vernacular architecture.

The Earth is a literally colorful planet when someone casts an eye over a physical map of it. There are yellow sections, brown ones, green ones, white ones, and the major blue ones. Only 30% of the planet’s surface is land which is not totally inhabited. Most of Canada, Alaska, and Greenland, much of Siberia, large parts of Mongolia, the Middle East, Arabia, and North Africa, and most of Australia are either deserted of lightly settled.

Colors of the map symbolize different climates and this irregular distribution of lands is one of the reasons, others being tilt in the axis, solar radiation, atmospheric pressure, prevailing winds, patterns of precipitation, ocean currents, level of humidity and biologic diversity. Climate is shortly defined as “weather conditions prevailing in an area longer than 30 years”. There are various climate classification systems, but Köppen’s is the most frequently referred. According to the Köppen Climate Classification system, there are 5 main types of climate: Arid (hot-arid), Tropical (hot-humid), Temperate (warm-humid), Continental

(warm-arid), and Polar (cold). The system divides each one into further parts according to local conditions (Image 2).

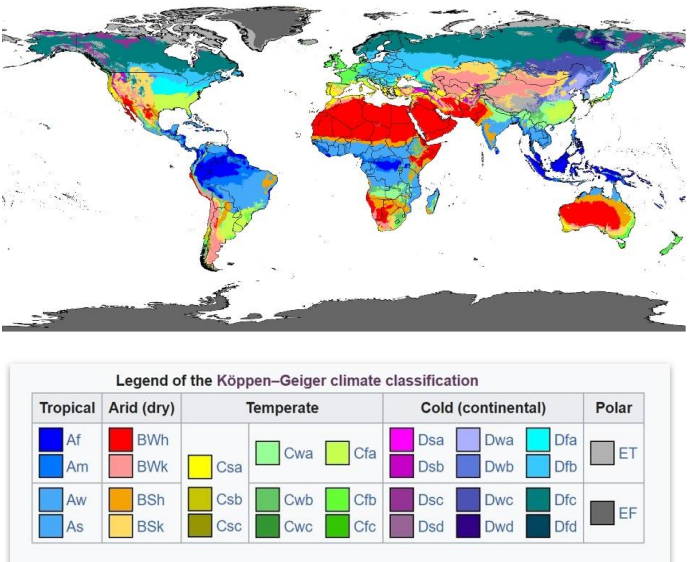

Image 2. Köppen Climate Classification map and legend[12]

Each climate zone has unique features and vernacular architecture has proper solutions. In fact, the buildings do not control climate but create a micro-climate in the interior spaces with extremely localized specific solutions. Therefore, the vernacular buildings reflect the climate in which they were built. Despite meager resources, the vernacular builders have designed dwellings that successfully meet the severest climate problems[13]. And we would expect to find the most forceful, enlightening solutions in those areas where the climate is severest[14]. The margin of error is quite smaller in those conditions because when the structure errs the inhabitants may face the unforgiving nature. In any part of the world, the

fundamental climatic needs are needed to be solved before talking about the more sophisticated requirements. The simple approach of climate responsive design is to benefit from the positive features and protect from the negatives. As local builders accept the nature not an enemy to take down, but as an ally to live within; the vernacular structures solve these challenges via the healthy, economic, and sustainable passive climatization techniques, which the modern architects desperately need to learn as soon as possible since the atmospheric changes, shifting seasons, global warming, and rise of sea levels are today's biggest threats.

The cold climate which also leads to polar biome is one of the two harshest types of conditions. In vernacular architecture, the structures become either smaller or in compact identity to decrease the surface area not to lose heat. Small and compact forms are wider, as seen in the famous hemispheric polar structures. Popular vernacular architecture examples are Igloo from Arctic Circumpolar Region, Quinzhee from Canada, and Chum from Siberia (Image 3).

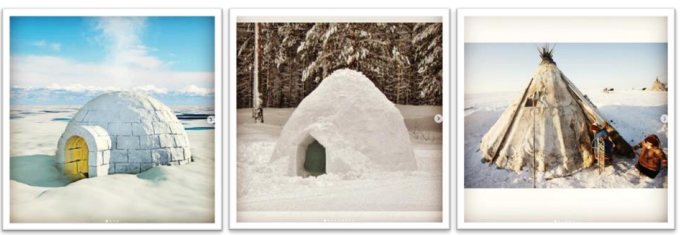

Image 3. Vernacular architecture samples from the cold climate[15]

The other equally-harshest condition is from the opposite side of the planet, hot-arid climate, or what we know as the desert biome. There is no precipitation and day-night temperature fluctuation difference is greater. Days are

extremely hot. The main concept of climate-responsive design in this continuous summer condition is the same with polar one, minimizing the heat transfer again with small or compact forms, but this time exterior to interior, in other words not to gain heat. Flat roofs, if existing, are installed several functions. Various cooling solutions were invented such as wind catcher chimneys and enclosed courtyards with water features in the Middle East. Structures are made of materials with high thermal capacity, which store the heat all day and transmit to the interior when needed at night. Popular vernacular architecture examples are Bedouin Tent from Arabsphere, Harran Houses from Turkey, and Taos Pueblo from United States (Image 4).

Image 4. Vernacular architecture samples from hot-arid climate[16]

The other hard condition, but not one of the two most extremes, is the hot-humid climate. This type of weather, also known as monsoon and savannah is seen mainly in Southeast Asia and Northern South America. This climate offers both frequent rain and strong solar radiation at the same time, which makes continuous moisture the main challenge. As solutions, vernacular builders try to direct winds into volumes with both rising the structures on piles and opening the façades. However, the roofs are still in thick and opaque identity to minimize the effects of the sun and heavy rains. This time, roofed verandahs take place of

the hot-arid courtyards. And separate buildings are erected with a distance, in order not to block the wind. Yet another solution in both sunny climates is to apply reflective lime plaster on the exterior surfaces. Popular vernacular architecture examples mentioned here are Rumah Adat from Indonesia, Ifugao from the Philippines, and Palapa from Mexico (Image 5).

Image 5. Vernacular architecture samples from hot-humid climate[17]

The last two climate types are warm-arid and warm-humid, in other words, the mild climates. As told before, those are not so challenging, and cultural or economic factors can be evaluated earlier. It is far easier to create microclimates within the comfort zone. However, here are both hot and cold seasons where there was single in other climates. Here the structure solves both seasonal variabilities, or the occupants built distinct structures matching with either season.

Of course, the climate is not the sole determinant of the vernacular structures, since so many forms have been developed within the limited number of climatic zones. The economy is the second input of this study and directly related to the first one. As mentioned above, certain

climates allow certain lifeforms and mankind is the only of them spread in all biomes. Humans manipulate the creatures around and create economies. The common definition of economy is something like “organization of production and consumption of goods”. However, in vernacular societies, it is mostly about food production and a small amount of tailoring or pottery. Of course, when life gives you lemons, you make lemonade but as Jared Diamond told in *Guns, Germs, and Steel*, geographical determinism denouncing human creativity and accepting mankind as passive robots helplessly programmed by climate, fauna, and flora is a misconception[18].

All social groups survive by the organization of the labor, and vernacular architecture does exist in all such categories, probably more in small groups with basic economies and less in the developed urban ones. This study divides the economies into four: subsistence, nomadic, agriculture, and industry (Image 6).

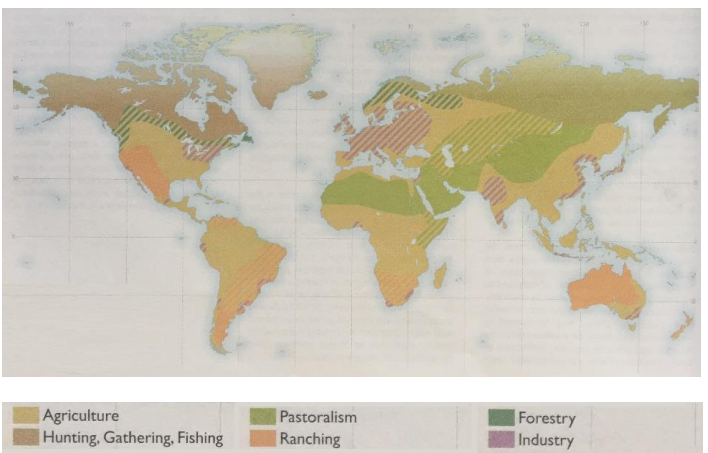

Image 6. Vernacular architecture based economies map and legend[19]

The subsistence economy is also known as the hunter-gatherers, people do not produce food. Their lifestyle is based on movement to the next station of resources. Such cultures are now few, but present in every continent. Yet another map of the world, the political one, displays borders and colored territories. The world seems to be divided into sovereign countries, but those people survive within them. And their architecture is based on what material is available around and subject to a short period of use. Bambuti pygmy hut form Congo and Gunyah from Aboriginal Australia can be examples of this kind of vernacular architecture (Image 7).

Image 7. Vernacular architecture samples from subsistence economy[20]

The second economy is nomadic pastoralists, who follow specific routes together with their herds. They raise cattle, camel, goat, or sheep and move between the pastures when the previous ones recover. Their architecture must adapt this transhumance way of life. As a demountable and portable structure, a tent is one of the cleverest inventions in architectural history. Tents are of two main parts, the standalone frame of branches mostly and the cover of herd animal skin, woven cloth of animal hair, felt, or even bark

draped over. Some kinds were supported by guy ropes and tent pegs. Most or all of the structural parts are loaded onto pack animals during the migration. Teepee from Northern America, Black Tent from Tibetan China, and Yurt from Central Asia can be listed as examples (Image 8).

Image 8. Vernacular architecture samples from nomadic economy[21]

The third type of economy is agriculture. The definition of this term is problematic since it is accepted as only horticulture, or gardening. It is, in fact, “cultivating plants, animals, and fungi for food and raw material production”. Agriculture is a key development for a sedentary life. The main agricultural products are wheat, rice, other cereal crops, vegetable, fruit as plants and cattle, sheep, swine, as well as poultry like chicken, turkey, goose, and duck. Approximately one-quarter of the world population, roughly 2 billion people are farmers. In terms of vernacular architecture, in addition to residences, outbuildings like granaries, barns, byres, and mills are needed in such economies. In contrast to agricultural societies, many peoples dwell near rivers, lakes or sea depend heavily on fishing.

The last form of economy is the industry. As expected, this type means developed societies, the urban half of the world’s population. Many of the buildings in cities are

designed by architects, however, the vernacular architecture survives in many of these areas but with continuity under threat. Many once villagers still migrate to cities to become employees of either factories or services. However, when the existing housing stock cannot meet the waves of immigrants, cities spawn suburbs or slums, which perfectly fit in the definition of vernacular architecture. Famous slums are Favela from Brazil and Barriada form Peru (Image 9). Because of their link with low-income, despair, and crime, slums are always objected to urban transformation projects but since their huge voting potential, governments treat them carefully. Some sources also list forestry as an individual type of economy and place it before the industry.

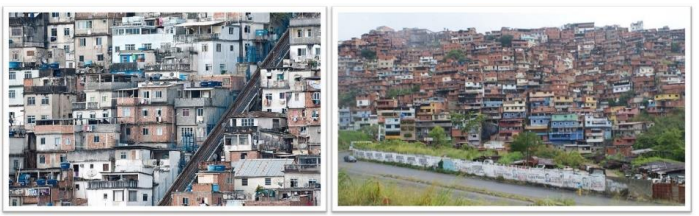

Image 9. Vernacular architecture samples from industrial economy[22]

Culture is the third and the last input of vernacular architecture according to this study. Certain forms of economies can support a limited number of people. Anthropologist Elman Service listed these sociopolitical typologies as bands, tribes, chiefdoms, and states[23], in order of population rise. While matching them with mentioned types of economies, bands and tribes are subsistent hunter-gatherers, chiefdoms are pastoralists, and states are those dealing with agriculture and industry. These social

organizations were settled via the economic inputs but sustain with the help of culture.

Speechless creatures adapt climate-defined biomes via biological adaption. Human, as mentioned above, is the only species spread in all climates before the biological evolution completed. On the other hand, the human is gifted with the ability of abstract thinking, and as far as we know, only human can talk about the beings they cannot see or touch. This amazing ability helped people create cultures, as protection in various conditions.

Culture is a complex term that is quite tough to define. Anthropologist Edward Burnett Tylor thinks it is that complex whole which includes knowledge, arts, morals, law, custom, and any other capabilities acquired by man as a member of society[24]. In the *Encyclopedia of Vernacular Architecture of the World*, Paul Oliver gives the following definition: the totality of values, activities, and products, including buildings, of a society that gave meaning and direction to the lives of its members. And this study prefers to define culture as "what human societies can collect around their physical and abstract surrounding". Culture's definition includes a great paradox. As anthropologist Melville Jean Herskovits summarizes, culture is universal in man's experience, yet each local or regional manifestation is unique[25]. In other words, it is the culture which separates the human from other creatures and unifies us all. Because each individual lives within a culture, at the same time, cultures define groups of people, which we automatically divide with entering into one.

Many scholars agree on the phenomenon that cultures are transmitted between generations. In other words, culture is not transmitted genetically but learned. And the transfer of knowledge is mostly done in oral. Though Rumi

thinks that “not the ones speaking the same language, but the ones sharing the same feeling understand each other”, linguist Tore Janson says if two people understand each other, they talk the same language[26]. Therefore, language is a key element defining the culture. Unfortunately, also language cannot solely determine the cultures. Nevertheless, language must take an important place in vernacular architecture research since many of the names of vernacular architecture samples mean literally “house” in the local language. Yet another form of transmission is writing systems. Anthropologist Robin Dunbar once coined that an individual could maintain a verbal relationship with a maximum of 150 people[27]. And historian Yuval Noah Harari thinks that only writing systems can help people to gather in larger quantities and develop chiefdoms or states[28]. Or in other words, as ethnologist Claude Lévi-Strauss believes, the primary function of written communication is to facilitate slavery[29]. However, in societies that built the vernacular structures, writing systems are either unknown or not commonly used. Therefore, the architecture itself becomes the record in understanding their way of life, the culture. In *Guns, Germs, and Steel*, Jared Diamond also accepts writing systems as a border between chiefdoms and states.

It is obvious that cultural zones are neither defined by nations, nor the political borders, nor the climate zones. A little study had been done in cultural mapping. For the *Encyclopedia of Vernacular Architecture of the World*, Paul Oliver redrew a cultural map of the world covering 65 distinct cultures, relating individual ones to culture groups sharing certain characteristics, as common architectural features (Image 10). Since the cultural groups are broadly defined, it becomes apparent that we cannot usefully

generalize about, for instance, “Indonesian” or “South Asian” vernacular. We learned that every island has different architecture and that this in turn may also be differentiated.

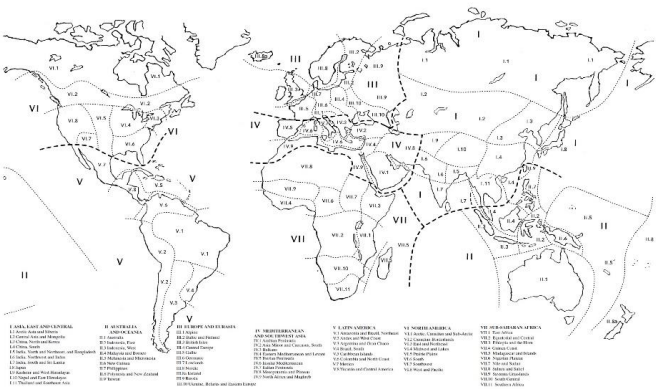

Image 10. Vernacular architecture cultures map[30]

Cultural products of mankind are generally divided into two, as intangible culture in one hand, and tangible or material culture in the other. The intangible part of cultural products can be listed as rituals, norms, music, religion, customs, skills, mythology, language, etc. When it comes to tangible culture, we need to talk about concrete objects. Many scholars accept material culture as the tools, outfits, and architecture of a society. Sociologist David Émile Durkheim says the society is composed of individuals only, and it also includes material objects which play an essential role in the common life, houses, buildings of all kinds, once constructed, become autonomous realities, independent of individuals[31].

A town is made of buildings where a community is made of people. The vernacular architecture here provides an emotional space too, rather than sole structural shelter.

We create cultural environments within physical environments. Complexes of cultural traits that bear upon architecture may be summarized as relating to economies and life support, family and social structure, communication and education, beliefs, values and symbols, and sociocultural continuity and change, and many others. Evaluation of building material and as well as the construction methods also fall into this category, again in terms of not only technical know-how but also the standards and values of a society embodied in its built structures. Vernacular traditions have evolved and have been perfected to also meet these sociocultural needs.

As understood, even since the culture map was also roughly drawn, it is impossible to categorize vernacular structures into cultural groups. However, distinct samples can be mentioned where the cultural effect is sharply visible on design. First is the Arabic settlements with a sociopetal courtyard. Since this is an introverted culture, structures of families of a larger lineage are placed around a central courtyard. This also is a place for communal activities and foreigners are strictly not allowed in. The second sample is from Far Asia. Since there is a complex cosmological system in Chinese belief, buildings and even the structural parts are placed in an orientation to comfort the famous Feng Shui principles. The third sample is from Malaysia. Stilts, carrying the main volume, are split from a single trunk to pacify the disturbed tree spirit. More, these stilts are aligned according to their original direction of growth to simulate their nature. Forth, the smoke hole above the Mongolian Yurts is mentioned as the “eye of heaven” and subject to many myths. Fifth is from Nigeria, where polygyny is widespread. Each wife has her separate hut where the husband has a larger one. The sixth sample is

from India and about norms in material use. Here, some societies banned the use of fired bricks in housing and wood in temples. In many parts of the world, the structure is expected as a human-scale model of the universe, and parts of the house are named in anthropometrical terms. And interiors are divided into dual parts as masculine-feminine, clean-dirty, life-death, or secular-divine. When the cooking and dining facilities are subjected, there are millions of varieties both in gastronomic methods and their architectural solution. Especially the hearths have cosmological meanings, in addition to heating and cooking functions. Even the communal buildings reflect the culture they emerged in. There are various meeting houses in the tribal level of societies. These "longhouses", the chief's house and the shaman's structure are sometimes built communally as a ritual. And even in the more complex urban settlements, communal places are still in distinct identity. Turks gather in "kahvehane", English in pub, Korean in tea rooms, Austrians in wine shops, and Americans in bar. And finally, the symbolism of vernacular structures must also be subjected while talking cultures. There is a vast collection of ornamentations and patterns in vernacular architecture decoration. Famous designs to mention are the tree of life, axis mundi, totemic poles, and Islamic patterns. Many of these motifs have ancient origins. They solely prove that, in opposition to secular urban life, religion and mythology still take a large share in vernacular societies. Surprisingly, little research has been undertaken on the aesthetics of these societies in decorating buildings. As understood, the local architecture is far more than the site it occupies, the material it is made, the knowledge of its construction. The vernacular structures are the theatre of lives.

This chapter of the study, Part I, focused on the definition, the academic study of the field, and the inputs, as well. And Part II is going to cover the outputs, the "other vernaculars", and the result.

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Chapter-2

A DETAILED NEW METHOD FOR VERNACULAR ARCHITECTURE RESEARCH PART II: OUTPUTS AND RESULT

Dr. Atlıhan Onat Karacalı

Vernacular architecture is defined by this study as follows, "*the architectural activity presented in a geography, over locally available materials and experienced technique, collaborating with local climate and running the cultural values, however without the employment of a professional designer"*. The vernacular architecture was once accepted as low-architecture since it was not the work of kings or priests but ordinary people. However, in recent 40 years, scholars, largely architectural historians restored the value of the field. Vernacular architecture studies are now a major section of interest.

Many studies tried to investigate the values vernacular architecture embodied, and some tried to understand the reasons resulting in structural design. For this cause, this study accepts climate, economy, and culture as the abstract inputs of vernacular architecture research and material, technique, and form as the outputs (Image 1).

Part I of this study focused on the definition, the academic study of the field, as well as the inputs. And here, the outputs and the result are going to be evaluated.

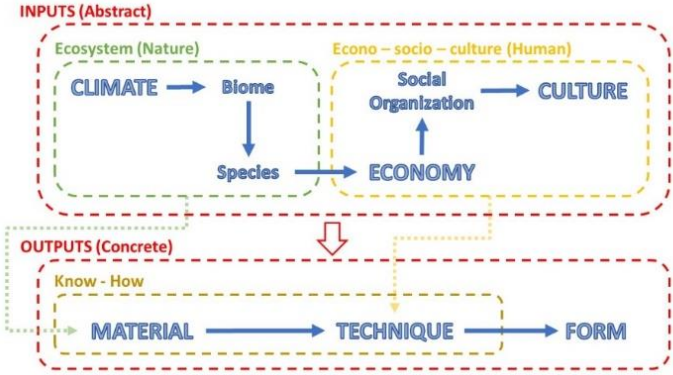

Image 1. Flowchart of the study

1. OUTPUTS OF VERNACULAR ARCHITECTURE RESEARCH

As mentioned beforehand, material, technique, and form are the concrete outputs of this study. This study acknowledges the definition of building material as follows, any item involved in the design and construction of architecture and came together to create the form of the structure. Material choice is a result of complex design decisions. As expected, many vernacular builders tend to use the closest set of dominant materials. Snow is plenty in the polar region, where wood is available in forests and earth is the obligatory option in deforested warmer surroundings. The physical map of the world proves this general gradient in material choice. Certain materials end after certain latitudes, but new ones replace them where people living in transitional places use both options. On the other hand, Author Charles Gritzner thinks that availability is not the main factor of material selection in vernacular architecture, he offers a new set of economic theories as comparative advantage, primary resource use, and diminishing return in *Construction Materials in a Folk Housing Tradition*[1]. Nevertheless, there is a universal rule, even since the Neolithic Age, of using temporary materials for housing and permanent ones for communal buildings as temples or meeting houses.

Most of the time, it is obvious that the vernacular builders face a challenging restriction of materials, compared with a formal architect. Therefore, they push the limits of structural features of what they have in hand and achieve inspiring results. Each material has unique structural qualities. Local builders are truly aware of what can and cannot be done with local goods, in details and they display vast wisdom of

material interpretation. This is the admirable part of vernacular architecture, they often outperform the formal structures, mainly in thrift, lifetime, and climatization features. Respect for the quality of materials is one of the most important lessons the vernacular architecture can and must teach[2]. Sometimes, vernacular builders have a wider material selection opportunity. Then, other reasons work during the decision phase, like fashion, beliefs, norms, prestige, technology, ease in use, and maybe the price. As understood, the vernacular architecture embodies the motto of sustainability, “reduce, reuse, recycle”, in both economic and environmental terms. In many parts of the world, materials from deserted buildings are evaluated while erecting new ones.

Vernacular structures are built either from the ground or with resources that grow. In other words, the vernacular material is divided into two main groups, earthen and organic ones. Earthen materials term means the earth itself, as well as stone, metal, and even snow. Organic group, on the other hand, is mainly of vegetative resources, the logs, branches, reeds, bamboos, and even fiber and leaves. There also are animal products used in vernacular architecture, but very restricted in quantity, like bones, hair, hide, horns, seashells, and even the dung.

Earth is the widest used construction material in the world (Image 2). According to distinct sources, between one-third and half of all structures are made of earth. Mud, turf, or soil, in every form the earth is cheap and effortless to obtain. It is vast and ready to use, at least with the minimum process. In some techniques, variable amounts of binding are inserted, like lime, sand, dung, etc. Of course, also some water is added to gain the mud ingredient where the degree of water affects the plasticity of the material. Used more frequently and in

sophisticated techniques, in places where timber is less frequent. People even invented unsupported vault techniques when the wood is non-existent. Earth is a compression material and can bear a considerable amount of vertical pressure. More, the earth has a very high thermal capacity which makes it useful in climates with high daily temperature fluctuation. Earth is a non-renewable material unlike the timber, but reusable. Earth from left structures can be decomposed to use in the mixture of new construction projects. Unfortunately, the earth is highly vulnerable to natural hazards, like floods, earthquakes, erosion, or rainfall. As mentioned, this study embodies rock, metal, and even snow into the earthen materials category. And further details of construction techniques are going to be discussed below.

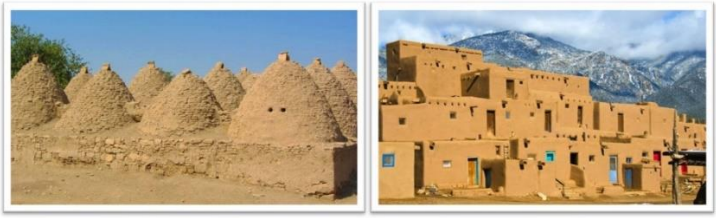

Image 2. Earthen vernacular architecture samples[3]

The other material group is of organic products. Naturally grown vegetation in various forms is widely used in vernacular architecture. As expected, wood is equally wide used with the earth in architecture, either formal or vernacular (Image 3). There are various techniques, which are going to be evaluated, from using logs with or without minimum process, to chop them into planks. Branches and even barks are also used in different details. The grass is evaluated to form ropes, twine, or cords. Leaves are used, mostly in dried

form, as coverings. Certain grasses, like wheat, barley, or rice are cultivated in large scales for food production but the left stems are also used in construction. Bamboo family is also a popular structural element in hot-humid climates. Vegetative materials are highly durable for architectural purposes mainly because of their tensile strength but bring together the serious risk of deforestation. Some cultures raise plants just for structural goals, but this, unfortunately, is not a worldwide attitude. There are also mixed techniques of using both earthen and vegetative products together, in vernacular architecture. Yet another small group of organic materials consist of animal products. Animal hides and fabric woven of animal hair are used as a covering membrane in many cultures. There are records of the use of bones as structural elements and horns as tent pegs.

Image 3. Vegetative vernacular architecture samples[4]

Though the main idea of locally available material, some cultures always imported structural goods. And with the modern inventions, mainly the railroads, many formal materials, like corrugated iron, joined vernacular

construction. For example, many modern yurts are covered with plastic instead of the traditional felt. And formal products like corrugated iron and discarded waste products such as beer cans or tires are used in urban vernacular samples. This kind of use makes the structure non-vernacular according to some scholars. However, this study accepts the existence of formal materials in vernacular architecture but labels them as challenging the definition. Materials symbol meanings, prestige, or statue. In many places, the traditional materials are now rejected for their link with poverty or low-status. And modern materials are welcomed even though their expensive or climatically inappropriate identity and unnecessarily use[5]. Western models, steadily replacing the traditional ones in terms of the design and construction, also cause cultural discrepancy. Studies investigating the disappearance of traditional methods and materials are quite rare[6].

Building materials and construction techniques are inseparable. The word “technique” comes from the Greek word for art, the “tekhne” and means the branch of knowledge or skill needed in making an object. As told before, certain materials make certain building techniques available. Stone is not available to stretch where the hides are unavailable to pile up. And some materials are available for different techniques. Therefore, remarkably diverse results can be achieved from the same material. Architecture relies on the one simple relationship between the load and the load-bearing element. All building materials have weight, therefore are affected by gravity. Static elements like walls and roof are called “dead loads”, where climatic factors like snow and wind, as well as the furniture and even the occupants themselves, are the “live loads”. Delivering the gravitational loads to earth is the duty of the structural system. Stresses on these building

components can be broadly classified as “tension”, “compression”, and “shear”. Most of the time, vernacular builders employ muscle power, through the use of tools like hammers, chisels, levers, or saws. Animal power is only used for transporting heavy materials or carrying the dismantled building in the transhumance economy. Vernacular construction uses the human proportions, like the imperial system, including inch, foot, yard, and many local variants.

This study labels the material – technique group of its outputs as “know-how”. Within the context of vernacular architecture, it embraces what is known and what is inherited, it includes the collective wisdom and experience of the society, it embodies the inherited knowledge of climate, topography, seasonal cycles, natural hazards, and sustainability[7]. As not only constructors but also occupants of the structures in question, the people of vernacular societies have to learn not only how to obtain materials and bring them together with necessary tools but also how to build according to norms and values of their communities[8]. Inevitably, this kind of construction process creates a unique specialized language and own terminology. Those make the know-how of each distinct society, even more esoteric. In many places, learning to build is a threshold of becoming a fully participating member of a community. And the skills are transmitted from one generation to next, as an educative process and part of their tradition. Since each individual is not equally skilled, some kinds of specialization become available like stonemason, carpenter, and blacksmith. This study also finds the existence of those masters in construction, as a challenge to the definition of vernacular architecture.

These vernacular techniques of course did not emerge in one day. Each of them is a result of centuries, or even millennia of trials and errors and are subject to a constant

change. And we are now in a position, as the vernacular builders often are not, to evaluate their techniques with modern architectural measurements, and compare them with cultures displaying similarity in climate, material, or technique. Yet vernacular architecture reveals a very high level of performance even when judged in the light of modern technology[9].

In sum, before the further details of material species, it is going to be useful to put forward the definition of technique this study coins, “know-how of what to do with the building material, or in other words, the knowledge of the method of construction”.

Earth itself, as the major part of earthen materials, is used with quite different techniques worldwide. The first technique is a very interesting one offering not to build up but carving. This technique includes the horizontally dug caves and vertically sunken pits. Both options result in unconstructed ready walls. They are sometimes supplied with partial construction of log, earth, or stone, as the Zemlyanka sample from Russia. Another very interesting sample is from Cappadocia, Turkey where interiors were carved out of the eroded volcanic tuff. The second technique is directly building with wet mud, known as “cob” in England and “swish” in Western Africa. The third technique is also known as sod which offers to cut bricks out of the turf. The fourth technique is rammed earth, “pisé de terre” in French, or “tapia” in Spanish. This technique is popular in France, Morocco, India, and China. The method is of forming a wall-sized wooden mold, filling with mud, and tamping with a pole until a compact layer is gained with the ejection of air bubbles. This technique is applied layer by layer to form a wall. The fifth technique is wattle-and-daub, also known as “baghdadi" in the Middle East. It is a mixed technique of earthen material

and vegetative one. The branches are weaved like forming a basket and this structure is plastered with mud. This is one of the most common techniques in the tropics and mid-latitudes. There also is an unusual method, called “superadobe”, of filling bags with earth or sand and piling them up. This latest technique was pushed by architect Nader Khalili.

Adobe is the most sophisticated method of earth, which must be evaluated separately. The term comes from the Arabic “altob” and means to form bricks out of mud, shaped either with hand or with wooden molds and finalized with either drying under solar radiation or firing in the kilns. Adobe displays high thermal capacity, which makes it an ideal tool in places with greater daily heat fluctuation, like hot-arid climates of the Middle East and North Africa. It absorbs the heat in the day and transmits into interiors when needed in the night. The harsher this climate gets, the thicker adobe walls built to adapt. One of the most interesting samples of sun-dried adobe is Musgum mud huts from Cameroon, in a pointed tall dome form. Yet another one is from North America and known as “pueblo”. American natives used sun-dried adobe even in the pre-Columbian era. Most famous of them, which also a tourism target, is Taos Pueblo from New Mexico, United States (Image 4). The term “adobe” is frequently used only for the sun-dried version where the baked one is called “fired brick”. Fired bricks are more expensive than sun-dried version since firing them consume enormous quantities of fuel, mostly wood. In many areas, it is only used by the wealthy. Fired bricks are brought together with suitable mortars. It is a more durable and more fire-resistant material than the stone. However, unlike the sun-dried adobe, it cannot be reused. This non-renewable feature, along with rising fuel costs and increased popularity of modern materials like concrete drive the use of fired brick

questionable. In especially in the Middle East, its application is relatively rare, mainly because of the absence of firewood to use as fuel[10]. Adobe is on its way to becoming a standalone academic field of study since many scholars are interested in the subject, with various ongoing researches and published studies.

Another earthen material, the stone is used in a few miles of its origin since it is heavy and expensive to transport. It is also challenging and time-consuming to quarry, carve, shape, and assemble the stone. Therefore, only sedentary people tend to use it. For its extremely durable identity, it is more frequently used in the communal buildings like temples or palaces, in the engineering projects like roads and bridges, and the defensive fortifications. Such major work needs specialized artisans and falls out of the definition of vernacular architecture. Nevertheless, though lesser than the earth, the stone is also used in vernacular projects. There are dry and wet techniques. Dry one is of piling the stones, and sometimes ending with a corbelled dome. Wet one, on the other hand, involves the mortar. A popular example of dry stone system is Trullo form Italy.

As told earlier, this study accepts snow in the earthen materials group. As expected, it is used in the northernmost geographies since Antarctica is uninhabited. Most famous igloos of Inuit people are temporary dwellings of hunting seasons. They are of snow cut into prismatic blocks and laid in a spiral orbit trimmed to slope inwards to form the hemispheric dome. This structure is later plastered with ice to increase its thermal quality and the interiors are furnished with hunted animal fur. Many igloos are partially underground or sunken like pit-houses. There are other techniques of snow like piling the snow and then carving. Another earthen material, the metal, was mentioned above.

This material is either reached vernacular people via trade, especially after the railroads or used by the urban vernacular surroundings.

As known, the other main material group of this study is organic ones, which are mainly vegetative products. Tough the problem of rapid deforestation, nearly one-third of the land in the world is still covered with forests. In humid areas of mid-latitudes, building in timber is the standard model of construction, thanks to this abundance.

There are two basic methods of timber construction. First is the use of logs as themselves with the minimum process. Log construction, known as “blockbau” in Germany, is the principal method using the dead weight, but not tensile properties, of the logs with piling them up. Of course, it consumes much wood that framing. Corner joints of the piled walls are the main problem and various interlocking details are provided worldwide, like “saddle” or “V-notch”. Famous examples are the Russian Izba and the German Black Forest House, the “Schwarzwaldhaus”. The other method is timber-framing, or in other words, the half-timber technique. Here, only the structural elements are of timber, and the tensile strength of the wood is used on the post-and-beam principle. Doubling the length of the beam halves the load it can bear but doubling its width and depth will quadruple its strength. Frames provide support, but not the screening. The curtain walls between the posts are filled with various materials and techniques all over the world. When the wood is plenty the infill is made of planks. Stone, mud, and woven bamboo are the other options. There are various framing techniques like the box frame, balloon frame, cruck frame, or English cruck frame. Half-timbering is preferred because of the timber exhaustion or the rising costs.

The wide used wattle-and-daub technique was mentioned in the earthen materials group. As a reminder, it is of woven branches plastered with mud. Another vegetative group of materials is of grasses, leaves, and reeds. Because of the attenuated length-width ratio, the grass is not suitable alone as a structural element, but thanks to its flexibility and elasticity features, they are tied together and used. Reeds, as a certain type of grass, are bundled together for structural use. The famous Marsh Arab guest house, the Mudhif from Iraq is a very interesting sample of vernacular architecture of this type. The other grasses and agricultural leftovers are used as a binding ingredient in the adobe. And some grasses, generally in dried form, are used in thatch roofs as covering.

Bamboo is a unique type of vegetative material. There are numerous types of bamboo, and some of them are cultivated just for construction purposes. As divided by nodes, bamboo allows bearing an extremely high compression with relatively light construction. Bamboos are also used in the post-and-beam technique in their tensile properties. More, because of its favorable material properties and rapid growth in higher population density places, bamboo sets to play an important part in the future provision of ecologically sustainable and culturally appropriate housing[11]. Generally, the risen stilt structures are made of bamboo where the piles allow living directly on the fish schools, or space below for dehumidifier winds, or protection from insects, wild animals, or foreigners, in different settings of the world.

Animal products, as mentioned earlier, are a small group of construction materials in vernacular architecture. There is historical evidence of using the rib bones of huge animals for structural purposes. On the other hand, the felt, hide, and fabric woven of animal hair are widely used spanning elements especially in tents, even today. More, we already

know that the dung, seashells, and even tallow and casein are used as a binding ingredient in mud for structural purposes or the plastering.

Before ending the techniques section, it is going to be useful also to mention the finishing and roofing methods. One of the most common vernacular finishes is mud plaster, with straw or similar additives, sometimes molded or colored for decorative reasons. Another common finishing is lime plaster which is applicable on earth, stone, or timber. Different additives, mainly animal products like fat, are welcomed for increasing the water resistance. And the reflective color of lime is widely used to decrease solar radiation. Roof, on the other hand, is always the main problem in vernacular architecture. A wide variety of local materials, in both earthen and vegetative forms, function as roof coverings, from grasses, leaves, straw, bamboo, bark, branches, timber and logs to shingles, shakes, tiles of turf, sod, mud, and even stone. Since the fired brick is resistant to water penetration, specially formed roof tiles are popular in widely distributed forms, like Chinese, Spanish, Greek, and Roman versions.

A special form of vegetative roofs, the “thatch” is another wide form (Image 4). Mainly in the tropical hot-humid areas, the thatch is the main strategy since the roof must be solid and opaque against the heavy rain and high solar radiation. However, the vertical surfaces are decreased for dehumidification purposes. Therefore, the structures become giant umbrellas. Thatch is the generic name for roof coverings made of dead plants, other than wood[12]. Grass and palm leaves are mostly used in Latin America, Sub-Saharan Africa, and Southeast Asia where straw and reed are common in Europe, China, and India. Although the major problem with thatch is mot the water leakage but high wind damage, it has genuine advantages like price, use of locally available

material, and reuse as fuel. Since them, thatch is the most commonly used roof covering in the world[13]. Various samples can be found in Floridan Seminole, United States, as well as Mexico, Caribbean, and Melanesia.

Image 4. Samples of vernacular architecture covered with thatch roof[14]

Teachings of vernacular architecture envelop techniques, as well as the materials. Since some of the local techniques were left and the modern prefabricated methods replaced them, especially after the Industrial Revolution, the humankind now has brand-new problems like global warming, deforestation, climate change, unrenewable energy consumption, etc. Hopefully, many vernacular builders still rely on the local methods, coupled with a disinterest in using advanced technologies and resources. As we know that the ecological irreversible threshold is near, we have a really short time in hand to study existing natural solutions of vernacular societies and adapt their strategies to formal architectural design.

The final output of this study is the form. After the materials were brought together via specific technics, the

concrete plastic entity of the structure outcomes, the form. The vernacular structures are rarely identical to one another. However, some commonalities are figured out, just like the form, for ease of the categorization. When talking about the architectural form, the basic three-dimensional shapes usually help. Nevertheless, the architectural form defines not only the geometrical shape of the structure, but also the two-dimensional plantype, extensions and openings, location and orientation of the single structure, and the neighborhood consisting of multiple structures.

A long-term discussion of architectural studies is the form determinants, tough the existence of popular terms like “form follows function” in architectural literature. The same debate is also on target of vernacular architecture research. In *House Form and Culture*, Amos Rapoport focused on the subject. Tough some studies offer the opposite, Rapoport thought that the climate is not the main determinant, since there are plenty of distinct vernacular solutions within the limited number of climates. He also rejected the material as the main determinant, since quite different forms can be achieved through the appliance of different techniques (Image 5). The reasons to employ one form or another is a complex and varied design decision that also involves many factors as inputs. The climate, economy, culture, material, and technique, as well as the topography, security, history, and function, have a considerable effect on the form where none of them is the main determinant alone.

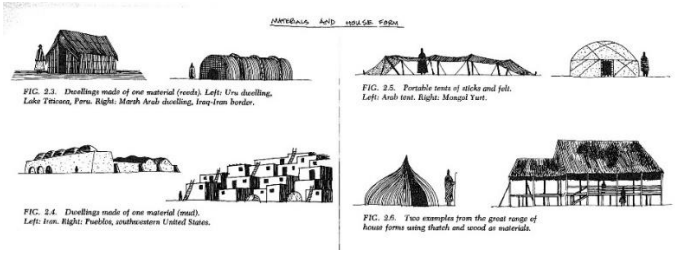

Image 5. Rapoport's sketches about the same materials resulting in distinct forms[15]

Plantypes are frequently discussed in architectural discourse. Some studies try to understand the difference between circular and rectangular plantypes, and some accept the oval shape as a transition. Many scholars believe circular plantype is more ancient since it is easier to construct for several technical reasons, and rectangular is accepted as a more developed plantype with sophisticated corner details. Igloo and teepee are of circular plantype, but quite distinct materials and techniques result in very different forms. In fact, without the third dimension reference, the height, plantypes are of limited value for vernacular architecture studies.

Nearly all vernacular structures can be abstracted to primary geometrical forms, the cone, dome, cylinder, and cube, or sometimes a combination of them (Image 6). The cone consists of a circular plan and inwardly inclined surfaces which terminate in a single point on top, like an upside-down ice-cream cornet. The cone is one of the widest used vernacular forms, found both as roof shape and as undifferentiated structure, where there is no visual difference between wall and roof, which is also called as "rooftecture" recently. It is used in the United States, Africa, and Northern Asia as well as in parts of Latin America and Southeast Asia.

Teepee and chum can be popular samples. Dome, on the other hand, is half of a sphere. It is found either hemispheric or parabolic. Dome is a perfect geometry in terms of covering maximum volume with the minimum surface area. Vernacular builders discovered this feature and used it when minimum heat transfer is desired. Another attribute of the dome is being agonic, in other words, it has no corners which makes this choice useful against loads of fierce winds. The dome is equally widespread with the previous option, the cone. Dome is mainly found in the circumpolar region, Mediterranean, Africa, and Central Asia. Popular vernacular examples are igloo, yurt, Musgum huts, and Dorze huts. The cylinder is a vertical plane rotated about a vertical axis. It is a less popular option in vernacular architecture and combined generally with a conical roof when used. This solution is seen in Europe, Africa, and isolated parts of Asia and Latin America. Various African rondavels and huts are obvious examples. The final form is the cube, which is square in plan and has a height nearly equal to one side of the plan. Used even lesser than other forms, cubes are generally left flat-roofed. It is found in the Mediterranean, Africa, and isolated parts of Southwest America and Central Asia. Taos pueblo is a good example.

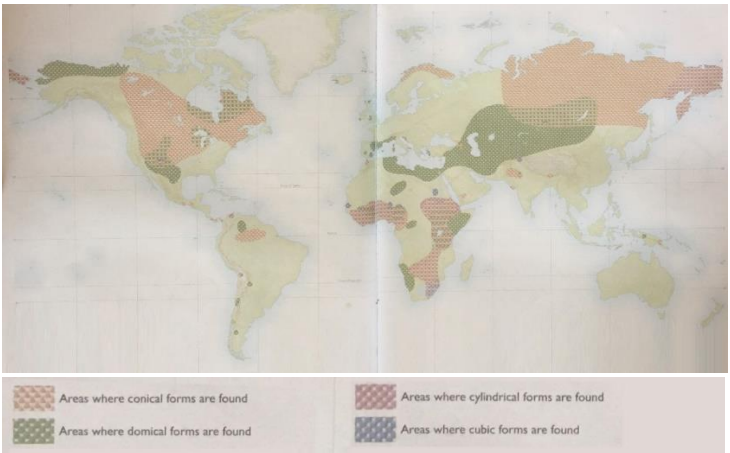

Image 6. Map of vernacular architecture based on the basic geometrical forms and legend[16]

The roof is once more a standalone subject and roof forms must be discussed separately. There are four types of roof forms in vernacular architecture, the flat, pitched (gable), hipped, and vaulted. Thatch roofs generally in domical form can also be listed. Flat roofs are of course found in places with less precipitation and they are the easiest form to construct. Flat roofs function in many ways, like drying food, airing clothes, sleeping, bird feeding, or movement when the structures are built adjacently. Gable roof is the most widespread form of roof consisting of two slopes meeting at the ridge and found anywhere in the world except the rainless places. Where rainfall is often and even the snow is seen, the pitch gets steeper with a high ridge, and vice versa, hotter the climate flatter the roof. Hipped roofs are less common covering a rectangular plan. Four slopes are coming together in either a point or a ridge. It has the advantage that all four walls are erected in the same height where the triangular gable

wall is not required. The vaulted roof is half of a horizontal cylinder. Built at places with serious wood shortage, using stone, earth, fired brick, or reeds. The most famous examples are Iraqi Madan mudhif and Indian Toda hut.

The vast majority of vernacular structures are single-story, but there are two or three-story examples and even high-rise ones as in Yemen. In two-story samples, the main strategy is placing the animals, and storage volumes on the ground floor where the living space takes place in the upper level. This approach helps to heat upstairs also with using the body heat of the livestock. Numerous structures have extensions like porches, verandahs, balconies, and yards which all make a spatial connection with the outer world. Especially the inward yards function domestic purposes like cooking, brewing, and washing.

Location, orientation, and the cluster are also important form features. Especially the introverted cultures tend to place the individual family structures of a larger lineage around an inner yard placed for the mentioned functions where the extroverted societies face the structures towards communal streets. Nevertheless, the Western urban grid plan is still unsuitable for many vernacular settings, where the expansion of neighborhood is aligned to topography, water access, or other resources. However, it is usual to cluster around the spiritual structure. Many villages, placed close to highways, are observable with an almost centrally placed church, mosque, or temple. Location and orientation are both aspects that deal with space and the position. Location is a consideration that usually has economic ramifications, while the orientation speaks to basic symbolic and religious aspects[17]. In Norway, wealthier farmers locate on sunny slopes. In the Alps, wooden structures are placed on the north-facing slope where stone ones on the south. In India, higher

casts dwell on the western part for beneficial prevailing wind. Orientation, on the other hand, means aligning a position with a reference to something else. In many fisher societies orientation to the sea is expressed, where agricultural economies tend to look roadway, easing the marketing of products. In China, Feng Shui decides what directs where. And in many Muslim societies, people try to face structures towards Mecca. As seen, settlements and orientations in indigenous contexts are unique to their specific circumstances[18].

Openings are also important while discussing the structural form. As expected, cooler climates force smaller openings where hotter ones allow greater. In polar regions, the doorway tunnel of the igloo is built at a lower level than indoors for the climate. Doorways, in many cultures, have symbolic importance along with the function. Entries are either blocked or do not face each other for privacy concerns. However, in northern Tanzania and among the pygmies of Congo a more interesting and complex system operates. Hut entrances face one another when inhabitants are on good terms, but away when animosity prevails[19]. Relatively light structures must be easier to rotate. Windows, on the other hand, have a greater number of functions like watching outside, gaining daylight, as well as ventilation and even the smoke escape. Using glass is very restricted in vernacular architecture since it is a modern material, as expected. Oiled paper, sealskin, pigskin, and fish gut are distinct glazing options. Windows also have symbolic meanings. In Europe, they are of four panes with a cross structure which is believed to function as a barrier against devil deities. In the Far East, they perform to create a path for the flow of cosmic forces, the “chi”. In the Middle East, rather than reducing the window size for needs of climate and privacy, a wooden fence, the

“mashrabiya” is installed which helps especially women in viewing the street unobserved. Since their complex symbolic importance, both doors and windows are frequently highly decorated in vernacular architecture.

2. THE “OTHER” VERNACULAR ARCHITECTURE

Tough its mainstream scope covers the abstract inputs and concrete outputs of vernacular architecture, this study finds the off-the-record discussion of “other” vernacular architecture a necessity. By the label “other vernacular”, this study embodies the urban vernacular, the new vernacular, the museum vernacular, the kitsch vernacular, and the fictional vernacular.

Urban vernacular is the slums those mentioned in industrial economies, like Brazilian favelas, Indian bustees, Peruvian barriadas, Turkish gecekondus, Moroccan bidonvilles, and many other similar illegal settlements. Some scholars exclude them from the definition since they are made of more modern material and structure. However, we may be witnessing the process of emergent vernacular and the acquisition of a new know-how[20]. No doubt these builders display a wise resourcefulness in terms of material recycling. For many studies, they are representatives of a new urban vernacular tradition.

The second one is the new vernacular which covers the studies of formal architects. Many modern architects claimed to draw inspiration from the vernacular architecture. Hassan Fathy, Geoffrey Bawa, and Charles Correa are the pioneers of this section where the famous projects like Fathy’s New Gourna and Renzo Piano’s culture center in New Caledonia must be mentioned briefly. These are wise colleagues who

tend to unlock the teachings of vernacular architecture, especially in terms of sustainability.

The third one is the problematic museums like *Skansen* of Sweden, *Openluchtmuseum* of the Nederlands, and *Muzeul Satului* of Romania, just to name few. Since the romantic tourist appeal of vernacular architecture, many governments focus on the concept of open-air museums of the local traditional architecture. Unfortunately, those are full of misconceptions like artificial works and misleading images of vernacular architecture. In recent years, in response to this criticism, the concept of eco-museum, in which structures are left in situ and are preserved in a natural context, has been developed[21]. Forth one, the kitsch vernacular, is more or less a similar attitude with museums. As a reaction to the tourist interest, awful hotel concepts of mimicking the vernacular architecture emerged recently, which are nothing but exaggerated, cosmetic, and even kitsch copies built by formal methods.

Fifth and the final "other vernacular" is the fictional ones. By the term "fictional", this study covers the nonexistent structures of novels, movies, and videogames, especially the ones of the fantasy genre. Structures in the distinct universes of *Lord of the Rings*, *World of Warcraft*, and *Avatar: The Last Airbender* franchises can be examples of superior quality. Cultures in these built fictional worlds make one think about who decides their buildings. Whoever they are, these designers must have a deep insight about vernacular architecture.

3. RESULT

The table below (Table 1) is an example of the goal this study planned to achieve. As the climate was labeled as the

origin, or genesis term of the flowchart displaying the inputs and outputs, two samples from each five climate group is chosen in the table, and they were categorized according to the other features.

	Inputs			Outputs		
	Climate	**Economy**	**Culture**	**Material**	**Technique**	**Form**
Igloo	Cold	Subsistence	North America (Arctic)	Snow	Masonry (Spiral)	Dome (Hemispheric)
Chum	Cold	Pastoralist	Asia (Siberian)	Reindeer Hide	Armature tent (Framed)	Cone
Bedouin Tent	Hot-Arid	Pastoralist	Mediterranean (North Africa and the Maghreb)	Animal hair fabric	Membra-neous tent (Frame-less)	Cube
Teepee	Hot-Arid	Pastoralist	North America (Prairie Plains)	Animal hide	Armature tent (Framed)	Cone
Rumah Adat	Hot-Humid	Agriculture	Australia and Oceania (Indonesia)	Wood	Post-and-beam	Cube (with gable roof)
Chickee	Hot-Humid	Agriculture	North America (South)	Wood	Post-and-beam	Cube (with gable roof)
Yurt	Warm-Arid	Pastoralist	Asia (Central Asia)	Felt	Armature tent (Framed)	Cylinder (with a conical roof)
Black Tent	Warm-Arid	Pastoralist	Asia (East Himalayas)	Animal hair fabric	Membrane-ous tent (Frameless)	Cube
Mudhif	Warm-Humid	Agriculture	Mediterranean (Mesopotamia)	Reeds	Bundled and vaulted reeds	Horizontal half cylinder (vault)
Musgum	Warm-Humid	Agriculture	Sub-Saharan Africa (Nigerian Plateau)	Sun-dried mud	Wet-built masonry	Dome (Parabolic)

Table 1. Inputs and outputs classification of vernacular architecture samples

Although we are in a position available to make cross-cultural comparison and categorization of vernacular architecture in many aspects, there still is a serious lack of studies. This study aimed to appoint the climate, culture, and economy as the abstract inputs and the material, technique, and form as the concrete outputs of vernacular architecture. As understood, the main purpose of the study is aiding vernacular architecture studies in terms of comparable and categorizable features that all structures can fit into. Of course, the flowchart this study puts forward needs further improvements and is open to criticism. Many studies must have resulted in the vernacular architecture field to learn the further teachings of local structures and make wider comparisons in between for a better comprehension and inspiration.

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Chapter-3

EVALUATING CAMPUS COMPONENTS ACCORDING TO THE INCLUSIVE DESIGN PRINCIPLES USING CFPR AND FANP METHODOLOGIES

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Abstract

Campus setting is a place for people to learn, meet, explore, think, or relax. Inclusive design is an important step for the accreditation system with the current legislation. The inclusive design has become important not only in terms of access to the campus or access to the building but also in matters such as the way lessons are taught and the curriculum. Eight performance indicators based on inclusive design principles are “Class climate”, “Interaction”, “Physical environment and products”, “Teaching methods”, “Information resources and technology”, “Feedback”, “Evaluation” and “Residential”. The prioritization or weighting of these principles can be addressed as a Multi Criteria Decision Making (MCDM) problem. For this reason, in this paper, Consistent Fuzzy Preference Relations (CFPR) and Fuzzy Analytic Network Process (FANP) are used for the evaluation of these principles and the results of both methodologies are compared.

Keywords: Campus climate; inclusive design; decision making; CFPR; Fuzzy ANP; MCDM.

1. Introduction

The public spaces of the city should be shaped according to need, as they have an important place in urban development. Because campuses function as small cities thanks to their facilities and social environment, they emerge as important public spaces. Campus areas affect our attitudes towards education and should be tailored to the needs and designed to cover all campus users.

Every individual who lives in the city and has the opportunity to participate in daily life in public spaces has the right to benefit equally from the opportunities and opportunities provided by the city where he lives. The concept of Inclusive Design has emerged to enable people

to reach the existing opportunities as equally as possible[1] and in its shortest definition it is defined as the process of designing products and environments that many people can use in many possible situations.[2]

An inclusive environment is unimpeded to ensure equal opportunities and participation for all. Design is more than shape and function, it is about being able to change people's attitude perceptions and how they interact with the environment. One obstacle that prevents them from taking their full place in society is based on the interaction between the individual and the built environment. People of different abilities, sizes and ages should be able to participate fully independently in society.

MCDM is a modeling and methodological tool for dealing with complex engineering problems. Decision makers face many problems with incomplete and vague information in MCDM problems since the characteristics of these problems often require this kind of information.[3] The CFPR and FANP are useful methodologies to solve MCDM problems.

There are many studies about CFPR method in the literature. Ozdemir et al.[4] determined personnel selection criteria and to prioritized these criteria by CFPR. Alias et al.[5] proposed a modified approach of consistent fuzzy preference relation with geometric Bonferroni mean operator for assessing the quality of life. Park et al.[6] utilized CFPR methodology, which handles both qualitative and quantitative factors in order to select optimal routes for small and medium ports (SMPs). Huynh and Phi[7] applied CFPR to select a strategy that attracts Foreign Direct Investment (FDI) in developing supporting industries for Vietnam.

There are many studies about FANP method in the literature. Hemmati et al.[8] proposed the FANP model and applied it to a sulfuric acid production facility for selecting the maintenance policy of an acid manufacturing company. Danai et al.[9] developed an FANP method for

selecting the best supplier in the supply chain. Alilou et al.[10] proposed a novel framework to assess watershed health using the FANP approach considering geo-environmental and topo-hydrological criteria. Galankashi et al.[11] developed specific criteria and an FANP method to prioritize and select portfolios on the Tehran Stock Exchange (TSE).

The rest of this paper is organized as follows: a brief description about inclusive campus climate is given in the 2nd section. CFPR methodology and the FANP methodology are explained in the 3rd and 4th sections, respectively. An application of CFPR and FANP methodologies in evaluating of campus components according to the inclusive design principles is given in 5th section. Also, computational results are given in this section. Finally, comparison of the results and future research directions are discussed in 6th section, which concludes the paper.

2. Inclusive Campus Climate

The university brings together individuals from different socio-cultural backgrounds. At the same time, the university contributes to the personal and intellectual development of individuals and functions as a socialization area. Universities create vitality with their social, cultural, economic, and spatial effects.

The climate on a university campus is a term used to discuss how individuals and groups experience the environment in the campus community. This is a general term that summarizes the inclusion dynamics of the organization and the extent to which the inclusion or exclusion of various stakeholders is felt. As climate-related conversations are naturally concerned with the real and perceived realities of different groups, this notion always embraces social identities defined in terms of race, ethnicity, gender, sexuality, disability, and an unlimited spectrum.[12]

The physical environment can be a source of some

opportunities, and the physical environment of the campus has a great psychological impact. Having socialization areas on campus directs individuals to spend more time on campus. Social opportunities offered by the campus; Structures such as show areas and sports halls turn the campus into a living space and have a positive psychological impact. The fact that all these opportunities can be used by everyone and that they are designed with the principles of inclusion creates a positive effect.

On the other hand, it is stated that university students are faced with various problems and needs that are getting more and more complex today.[13, 14, 15] Such problems may be related to developmental needs or situations, as well as various relationship problems, academic concerns, stress, depression, suicidal thoughts, personality disorders, and exposure to sexual assault.[16] Therefore, it is of great importance to determine the changing academic, social, personal, and professional needs of students at regular intervals and to plan the services offered by student support units in the light of these requirements.[17] In addition, the understanding that faculty members, academic advisors, university administrators, and specialists working in student support units, in short, all academic and administrative staff working at the university should have sufficient knowledge and experience about the changing needs of students should be adopted.[18]

Inclusive design principles can also be applied to specific teaching materials, facilities, and strategies (such as lectures, classroom discussions, group work, web-based teaching, laboratories, fieldwork, and demonstrations). The inclusive curriculum offers students a variety of tools to present, express, and participate in a variety of abilities, disabilities, ethnicity, language skills, and learning styles. Below are examples of teaching using the principles of inclusion. It is organized into eight categories of performance indicators, each with one goal expression.[19]

Eight performance indicators that should be included in campus components according to inclusive design principles are evaluated as follows.[19]

Class climate; Adopting practices that reflect high values in terms of both diversity and inclusion; To seek the views of students to discuss their curriculum, disability-based, and other special learning needs.

Interaction; To encourage regular and effective interactions between students and lecturers and to make communication methods accessible to all participants; to make students do group work.

Physical environment and products; Ensure that facilities, activities, materials, and equipment are physically accessible and usable by all students and that all possible student characteristics are addressed with security considerations; Developing safety procedures for all students, including the blind, deaf, or wheelchair users.

Teaching methods; To use accessible teaching methods accessible to all learners; enable students to choose from multiple options for learning whenever possible, lectures, collaborative learning options, real-time activities, internet-based communication, educational software, fieldwork, etc. Thinking about such matters.

Information resources and technology; Ensure that course materials, notes, and other information resources are interesting, flexible and accessible to all students; Choose printed materials and prepare an early curriculum to allow students to read the materials and start working on assignments before the lesson begins, organizing alternative formats such as books in audio format.

Feedback; Provide specific feedback; allowing students to present some of the major projects for feedback before the final project is over.

Evaluation; Regularly assessing the student's progress using multiple accessible methods and tools and adjusting the instructions accordingly; to evaluate group performance and individual success.

Residential; Planning for students who do not meet their needs with educational design; Knowing campus protocols for receiving materials in alternative formats, rescheduling classroom spaces, and arranging other handicapped accommodations.

3. Consistent Fuzzy Preference Relations Methodology

Consistent fuzzy preference relations (CFPR) proposed by[20] simplifies the pairwise comparison. The methodology only requires $n-1$ judgments for a preference matrix with n elements. Moreover, CFPR provides better consistency, because it reduces judgment times. CFPR determines the relative importance of main criteria and subcriteria by computational procedure discussed in.[21, 22]

The steps of CFPR can be listed as follows:[23, 24]

Step 1: Risk identification. Main criteria and subcriteria are determined.

Step 2: Degree of preference. Linguistic terms and corresponding numbers are presented in Table 1 and they are used to obtain pairwise comparisons.

Table 1. Linguistic scale.

Definition	**Relative Importance**
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Absolutely more important	9
Intermediate values	2, 4, 6, 8

Step 3: Comparison. Construct pairwise comparison matrices amongst the criteria $(C_i,\ i=1,\dots,n)$. Pairwise comparisons for a set of $n-1$ preference values are provided by the decision makers.

Step 4: Transformation. Transform the preference value $a_{ij} \in \left[\frac{1}{9}, 9\right]$ into $p_{ij} \in [0,1]$ through (1).

$$p_{ij} = \frac{1}{2} \times (1 + log_9 a_{ij}) \tag{1}$$

Then, calculate the remaining p_{ij}^k by using (2), (3) and (4).

$$p_{ij} + p_{ji} = 1 \tag{2}$$

$$p_{ji} = \frac{j - i + 1}{2} - p_{i(i+1)} - p_{i+1(i+2)} - \cdots - p_{j-1(j)} \tag{3}$$

$$p_{ij} + p_{jk} + p_{ki} = \frac{3}{2} \tag{4}$$

This preference matrix can contain values included in the interval $[-a,\ 1 + a]$ rather than in the interval$[0,\ 1]$. In this situation, to preserve reciprocity, a transformation function is used. The transformation is found by (5).

$$f(p_{ij}) = \frac{p_{ij} + a}{1 + 2a} \tag{5}$$

Here a indicates the absolute value of the minimum in this preference matrix. Likewise, the fuzzy preference relation matrices for all decision makers are calculated.

Step 5: Aggregation. Aggregate the fuzzy preference relation matrices to find the importance weights of the selection criteria. Let p_{ij}^k denote the transformed fuzzy preference value of the k -th decision maker for criteria i and criteria$j$. The average value method (6) is used to integrate the judgments of m decision makers. The total number of decision makers is denoted as m.

$$p_{ij} = \frac{1}{m}(p_{ij}^1 + p_{ij}^2 + \cdots + p_{ij}^m), \quad k = 1,2, \ldots, m \tag{6}$$

Step 6: Normalization. Normalize the aggregated fuzzy preference relation matrices. h_{ij} is used to indicate the normalized fuzzy preference value of each criteria in (7) and the normalized fuzzy preference relation matrix is found.

$$h_{ij} = \frac{p_{ij}}{\sum_{i=1}^{n} p_{ij}} \quad i, j = 1,2, \ldots, n \tag{7}$$

Step 7: Prioritization. Calculate the importance weight of each criteria (8).

$$w = \frac{1}{n}\sum_{j=1}^{n} h_{ij} \tag{8}$$

4. FANP Methodology

Analytical Network Process (ANP) was introduced by Saaty[25] and is a generalization of the Analytical Hierarchy Process (AHP).[25] Saaty[25] suggested using AHP to solve the problem of independence over alternatives or criteria and ANP to solve the problem of dependence between alternatives or criteria.[26] ANP is used to evaluate the priorities of the elements in the network and the alternatives of the goal. ANP allows modeling complex and dynamic environments affected by changing external factors.[27] Buckley's fuzzy AHP algorithm[28, 29, 30] based fuzzy ANP is used for weighting the Design principles in this paper.

The steps of FANP can be listed as follows:[31,32]

Step 1: Determine alternatives, criteria and subcriteria to be used in the model.

Step 2: Create a network of alternatives, criteria, subcriteria, inner and outer dependencies among the model.

Step 3: Build pairwise matrices of the components with fuzzy numbers by the experts.

Step 4: Construct the fuzzy comparison matrix by using fuzzy numbers:

Step 5: Calculate fuzzy eigen value to find whether the constructed matrix is consistent or not:

To verify the consistency of the comparison matrix, Saaty[25] proposed a consistency index (C.I.) and consistency ratio (C.R.). The consistency index of a matrix is given by

$$C.I. = (\lambda max - n)/(n-1)$$

$$C.R = C.I/R.I$$

where, R.I is Random Consistency Index. The consistency index should be less than or equal to 0.10.

Step 6: Form initial supermatrix of the network of ANP is composed by listing all nodes horizontally and vertically.
Step 7: Obtain weighted supermatrix by multiplying the unweighted supermatrix with the corresponding cluster priorities
Step 8: Calculate limited supermatrix by limiting the weighted supermatrix by raising it to sufficiently large power so that it converges into a stable supermatrix (i.e, all columns being identical).
To solve the problem using FANP, fuzzy numbers are used as shown in Table 2.

Table 2. Relationship between fuzzy numbers and degrees of linguistic importance.

Low/high Levels		Fuzzy Numbers
Label	**Linguistic Terms**	
E	Just equal	(1,1,1)
SL	Slightly Low	(1,1,3)
M	Middle	(1,3,5)
SH	Slightly High	(3,5,7)
H	High	(5,7,9)
VH	Very High	(7,9,9)
EH	Extra High	(9,9,9)

5. Application: Evaluating the Campus Components

In this paper, performance indicators based on inclusive design principles are studied and prioritizing the criteria using Multi Criteria Decision Making (MCDM) techniques, Consistent Fuzzy Preference Relations (CFPR) and Fuzzy Analytic Network Process (FANP) is aimed. In order to prioritize, eight performance indicators based on inclusive design principles referred as criteria were identified and evaluated by 3 experts from academia and industry. These criteria are Class Climate (C1), Interaction (C2), Physical Environment and Products (C3), Teaching Methods (C4), Information Resources and Technology (C5), Feedback (C6), Evaluation (C7), and Residential (C8).

All experts were asked to determine the importance of criteria based on Table 1 (for the CFPR methodology) and Table 2 (for the FANP methodology).

Firstly for the CFPR methodology, the pairwise comparison matrices for the criteria were provided by decision maker 1 are shown in Table 3.

Table 3. Fuzzy preference pairwise comparison matrix of decision maker 1 for the criteria.

	C1	C2	C3	C4	C5	C6	C7	C8
C1	1	3						
C2		1	0.33					
C3			1	1.00				
C4				1	1			
C5					1	1		
C6						1	1	
C7							1	1
C8								1

Then, the remaining p_{ij}^{k} for the criteria are calculated by using Eq. (1), (2), (3) and (4) (Table 4).

Table 4. Transformed fuzzy preference values of decision maker 1 for the criteria.

	C1	C2	C3	C4	C5	C6	C7	C8
C1	0.5	0.75	0.5	0.5	0.5	0.5	0.5	0.5
C2	0.25	0.5	0.25	0.25	0.25	0.25	0.25	0.25
C3	0.5	0.75	0.5	0.5	0.5	0.5	0.5	0.5
C4	0.5	0.75	0.5	0.5	0.5	0.5	0.5	0.5
C5	0.5	0.75	0.5	0.5	0.5	0.5	0.5	0.5
C6	0.5	0.75	0.5	0.5	0.5	0.5	0.5	0.5
C7	0.5	0.75	0.5	0.5	0.5	0.5	0.5	0.5
C8	0.5	0.75	0.5	0.5	0.5	0.5	0.5	0.5

Preference values transformed by transformation function for the criteria are obtained by Eq. (5) (Table 5).

Table 5. Preference values transformed by transformation function for the criteria.

	C1	C2	C3	C4	C5	C6	C7	C8
C1	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.50
C2	0.33	0.50	0.33	0.33	0.33	0.33	0.33	0.33
C3	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.50
C4	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.50
C5	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.50
C6	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.50
C7	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.50
C8	0.50	0.67	0.50	0.50	0.50	0.50	0.50	0.50

Likewise, the fuzzy preference relation matrices of the other 2 decision makers for all criteria are calculated by using above computational procedure.

To integrate the judgments of 3 decision makers Eq. (6) is used and the normalized fuzzy preference relation matrices for the criteria are calculated by using Eq. (7). Finally, the importance weight of the criteria determined by three decision makers using Eq. (8) can be seen from Table 6.

Table 6. Importance weights of the criteria.

	Importance weight	Ranking
C1	0.156454488	1
C2	0.120506502	3
C3	0.156454488	1
C4	0.134885696	2
C5	0.113316905	4
C6	0.091748113	5
C7	0.091748113	5
C8	0.134885696	2

Secondly, to solve the problem using FANP, we used triangular fuzzy numbers as shown in Table 2 and compared our results with those of experts. Different experts' assessments are aggregated using arithmetic mean method. Evaluations of the criteria by 3 experts can be seen on Table 7.

Table 7. Average values used in Fuzzy ANP

	C1			C2			C3			C4		
C1	1.00	1.00	1.00	1.00	1.00	1.00	0.20	0.33	1.00	0.33	1.00	1.00
C2	1.00	1.00	1.00	1.00	1.00	1.00	0.20	0.33	1.00	0.33	1.00	1.00
C3	1.00	3.00	5.00	1.00	3.00	5.00	1.00	1.00	1.00	1.00	1.00	3.00
C4	1.00	1.00	3.00	1.00	1.00	3.00	0.33	1.00	1.00	1.00	1.00	1.00
C5	1.00	1.00	1.00	1.00	1.00	1.00	0.20	0.33	1.00	0.33	1.00	1.00
C6	0.33	1.00	1.00	0.33	1.00	1.00	0.14	0.20	0.33	0.20	0.33	1.00
C7	0.33	1.00	1.00	0.33	1.00	1.00	0.14	0.20	0.33	0.20	0.33	1.00
C8	1.00	1.00	3.00	1.00	1.00	3.00	0.33	1.00	1.00	1.00	1.00	1.00
	C5			C6			C7			C8		
C1	1.00	1.00	1.00	1.00	1.00	3.00	1.00	1.00	3.00	0.33	1.00	1.00
C2	1.00	1.00	1.00	1.00	1.00	3.00	1.00	1.00	3.00	0.33	1.00	1.00
C3	1.00	3.00	5.00	3.00	5.00	7.00	3.00	5.00	7.00	1.00	1.00	3.00
C4	1.00	1.00	3.00	1.00	3.00	5.00	1.00	3.00	5.00	1.00	1.00	1.00
C5	1.00	1.00	1.00	1.00	1.00	3.00	1.00	1.00	3.00	0.33	1.00	1.00
C6	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.20	0.33	1.00
C7	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.20	0.33	1.00
C8	1.00	1.00	3.00	1.00	3.00	5.00	1.00	3.00	5.00	1.00	1.00	1.00

The fuzzy weight matrix of the criteria is given in Tables 8. The evaluation and the methodology described above produced the results shown in Table 9.

Table 8. Fuzzy weight matrix of the criteria

	l	m	u
C1	0.04	0.10	0.23
C2	0.04	0.10	0.23
C3	0.09	0.26	0.70
C4	0.06	0.15	0.40
C5	0.04	0.10	0.23
C6	0.02	0.07	0.16
C7	0.02	0.07	0.16
C8	0.06	0.15	0.40

Table 9. Weights of the criteria

	Weight	Ranking
C1	0.125968	3
C2	0.125968	3
C3	0.349346	1
C4	0.204678	2
C5	0.125968	3
C6	0.083594	4
C7	0.083594	4
C8	0.204678	2

6. Conclusion

The concept of Inclusive Design has emerged to ensure that individuals can benefit from all opportunities equally. Inclusive Campus Climate is a term used to discuss how individuals and groups experience the environment in the campus community. Campus climate includes the diversity of individuals, the experience of individuals, and communication between individuals. The campus climate should be places where all individuals with or without disabilities can receive education together.

Although the characteristics of the campus physical environment theoretically include all possibilities, the layout, location, and arrangement of spaces and facilities

can make some behaviors more likely than others. Campuses create an overall perception of their work, education, accommodation, recreation, and sports units, green areas, and circulation areas.

In this paper, multi criteria-decision making techniques, CFPR and FANP methods are used for the evaluation of campus components according to the inclusive design principles. As a result of evaluation process, these two MCDM methods have determined the most important design component as “Physical environment and products” (C3). And the least important design components in both methodologies are “Feedback” (C6), and “Evaluation” (C7). The ranking of the other indicators vary due to the differences in two methodologies. It is recommended that this ranking be taken into account when designing inclusive university campuses.

For future researches, the problem could be solved by other MCDM techniques. Also, the trapezoidal fuzzy sets instead of triangular fuzzy sets could be used for decision making and intelligent software to calculate solutions automatically could be developed.

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