

# Use of Kinetic Architecture in Addressing the Housing Challenges of the Nomadic Fulbe in Nigeria

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**Abstract**—The paper presents the potential of kinetic architecture as a solution for addressing the housing challenges of the nomadic Fulbe in Nigeria. The term “*nomad*” is derived from the Greek word *nomas* which refers to a person, people or communities whose way of life is based on systematic and periodic migration. The Fulbe tribe comprise the largest group of nomads in Nigeria, significantly confronted by housing (shelter), education, health, and sanitation problems. Hence this study proposes the adoption of Kinetic Architecture as a practical solution to the housing problems of the Fulbe. Hence, the paper reviews the current state of Fulbe housing, the nature and typology of Fulbe architecture as well as the factors to consider in proposing housing for the nomads. In addition, the fundamentals of kinetic architecture, its classifications and potential as a future solution to housing for Fulbe nomads is presented. In conclusion, the paper finds that kinetic architecture has the potential to provide buildings with mobility, movement and geometry which can meet the ever changing needs of nomads particularly in relation to varying climatic and ecology conditions. The integration of kinetic architecture into future housing plans for nomads will potentially reduce the overall impact of their activities on the environment.

**Keywords**—Retractable, Vault Covered, Migrant-Fulbe; Housing and Review

## I. INTRODUCTION

The term “*nomad*” is derived from the Greek word *nomas* which refers to a person or group of persons belonging to a group of people who reside in various locations periodically moving with time. In addition, *nomad* also refers to communities or societies whose culture and way of life is centered on the need to systematically travel distances in search of sustenance while maintaining their distinct identity as a people and sustaining themselves with animals and skills. As a result, the term nomad is frequently, albeit

erroneously, associated with “directionless wandering”. However, anthropologists have over time proved that the movement of traditionally nomadic people is far from chaotic but predetermined and systematic, often significantly influenced by their immediate environment. Since most nomads reside in severe environmental climates like deserts and steppes and tundra, mobility has become an absolute necessity [1, 2]. Therefore, Nomadic people frequently migrate as an efficient strategic necessity to search for scarce resources often spread across vast territories. By and large, nomadism can be also be attributed to increase in wants, uncertainty and serious threat to existence [3]. It can also be viewed as a human ecological reaction to its endangered environment, typically influenced by the basic instincts of survival and sustenance. Consequently, the manner in which various nomadic peoples across the world interact with their environment has led to the classification of nomads into three basic groups; hunter-gatherer, traders or craft-workers and pastoralists [1].

The hunter-gatherer nomads are predominantly people who travel in search of animals and foodstuffs to hunt or gather. Examples of these group of nomads include the Aborigines of Australia, Boso fishermen of the Niger River, Bushmen of Southern Africa, San of the Kalahari Desert, the Inuit of the Canadian Arctic, and native people of the Amazonian rainforest in South America [1, 2]. These nomadic group has also been described as shifting cultivators who migrate in search of fertile land to cultivate and grow crops for their sustenance. Typically, they are known to also migrate in response to the limited supply of food in a given locale or geographical setting.

The traders or craft-workers represent another group of nomads and often also referred to as *peripatetics*. These group of nomads are known to travel, migrate or relocate in search of improved conditions for their livelihoods which typically consists of craftsmanship, entertainment or trading. Examples of peripatetic nomads are the Gadulyia Lohars of India, Gypsies of Europe [2].

The last group of nomads are referred to as pastoralists. These typically comprise of communities

who seasonally migrate with their entire families in search of pasture for their livestock. Livestock plays an essential role in the existence and typically forms the basis of the culture of pastoralists. Examples of pastoralists are the Bedouin of the Middle East and North Africa, The Sami of Scandinavia and the Fulbe of West Africa [2, 4]. The ideals of self-sufficiency strongly hold sway among pastoralists effectively creating a disconnect between these groups and the wider society [5]. The pastoral nomads are also known to believe in the existence of deities. As such this group of nomads view their natural environment as the basis of divine design which must neither be destroyed nor modified. They also hold the strong belief that their seasonal rhythm through migration in search of a better environment for the cattle, pasture land as well as land that is free from cattle diseases is an endless life style [6].

Among the three major groups, the pastoral nomads are considered the largest and commonest group of nomad around the world. They are known to travel great distances around the world in search of scarce natural resources such as pasture and grazing to maintain their livestock. As a result, their migration, culture and interaction with the environment is the basis for numerous scientific research around the world. This is particularly evident in regions such as sub-Saharan Africa where large populations of various nomadic groups exist and co-exist. These include the Fulbes, Tuaregs, Massai,

Shuwa-Arabs, the Kwanyaro, Baduma of Borno; the Azbenáwa and Buzu communities [7].

The Fulbe, Shuwa-Arab, Baduma and Kwanyaro have been identified as the four major nomadic tribes in Nigeria. Together these tribes account for almost 7.5 % of the entire Nigerian population of 170 million people. However, the pastoral Fulbe of the Northern eastern region are considered the largest group of nomads comprising 11.32 million or 6.66 % of the Nigerian population distributed across the 19 states of the federation [8]. The Fulbe, also more commonly called the Fulani, are known to seasonally migrate by traversing large distances across the country in chiefly search of pasture for their livestock and sustenance. With this distinction, the Fulbe are considered the only truly non-agricultural pastoral group in Africa [9].

Geographically, the Fulbe can be found all over the Savannah belt of West Africa from Senegal to Central Africa Republic with higher concentration along the valleys of the major rivers, as presented in Fig 1. Like pastoralists the world over the Fulbe in West Africa are engaged in a livelihood, from that Johnson aptly describe as “ecologically adjusted at a particular technological level to the utilization of marginal resources”. Nowhere is this marginality of resources more pronounced than in the field of Fulbe nomadic architecture, housing and settlement. Needless to emphasize the fact that the “technological level” in the case of the Fulbe pastoralists is very rudimentary or rustic.



Fig 1. Fulbe concentration in West Africa

The ownership of livestock particularly, cattle among the Fulbe is considered a conduit to social importance in the sociocultural strata of the people. Consequently, ownership of cattle establishes ones membership in the society while losing this value resource could mean expulsion. A man's first ambition as a pastoral nomad in Fulbe culture is to

own a herd of cattle to attain social standing within his society. The degree to which he subsequently gains status and prestige will depend on his ability to establish the nomadic society as a distinctive ecological, ethnic and cultural group within the larger society. Therefore, the cultural ideology of the Fulbe, requires ownership and maintenance of a large herds

of cattle, inculcating the spirit of cultural oligarchy in the mind of their children as well as the maintenance of pure matrimonial lineage through endogamous marriage culture. The nomads are highly sensitive and tend to flee from any environment that poses threat to the existence of their herds. They are also highly guided by a number of codes of conduct and any serious breach of such code could manifest in reduction in the fertility and milk production as well as increase in the mortality of the herd upon which the offender is dependent.

Over the years, their seasonal migration, cultures and interaction with the environment have become a topic of national debate in the country and scientific research amongst various Nigerian scientists. As a result, the annual, seasonal migration of the Fulbe and their livestock as well as the effects of their mass movement across the country significantly affects the sociocultural, economic and environmental activity across of the nation. As a direct consequence, interest in the Public Health, Education and Housing of the Fulbe is now of paramount importance to the nation.

Consequently, the Federal Government, Academic Institutions and various organizations in Nigeria and abroad have commissioned numerous studies to gain comprehensive understanding of ways of nomadic Fulbe tribe with the view to improve their living standards as well as national development. To this effect, the Nomadic Education Programme (NEP) was set up by the Federal Government in 1990 to take care of educational needs of the nomads. The programme sought to identify and understand the reasoning, aspirations and improve needs of the nomads. However, these studies have never critically explored the concept of housing and provision of shelter for the nomadic Fulbe people [10].

In most nomadic populations, the housing provision is essentially fulfilled by the individuals and their communities' particularly since the government cannot cater for their needs such as housing while they migrate. As a result, nomads must seek shelter, sustenance and pasture for their livestock from their immediate environments typically located away from urban nor rural areas [11]. In response to their ever changing needs, the Fulbe temporary architectural structures evolve organically in response to the needs of its beholders. Characteristically, these structural forms mainly serve provide functional spaces, using light and easily erectable components which are not required to last for more than one year [12]. However, the migrant Fulbe structures does not protect the occupants from weather conditions or external attack as the materials are not strong, hard and durable. Hence the structures cannot be considered reliable, weather proof or resistant to climatic agents. Furthermore, the uncontrolled erection and situation of unplanned, unapproved structured housing among the Fulbe potentially contributes to social, ecological and environmental

problems such as desertification, waste disposal, water, health, safety and sanitation.

In response to the potential problems of uncontrolled nomadic migration and the housing crises thereof governments around the world have sort to steer communities into more consciousness, through their unceasing attempts to make them sedentary. The NEP of the Nigerian government is an example of such attempts. However, these efforts have failed to provide practical solutions to the housing problems of nomads [13].

Furthermore, the ostensible omission of a specific housing scheme for the nomads in the series of reports of "Agenda 21" of the United Nations (UN), under the Global Shelter Strategy to the year 2000 and beyond, has further established doubts in genuine intention of the state in enhancing the quality of life of the nomads. This omission becomes more serious in view of the fact that the nomads constitute about 40% of the total rural population in the world [14]. More so, this has seemingly create a false belief that nomads are "housing carefree" individuals with no natural instinct for housing. This is indeed erroneous as preliminary studies carried out on some nomadic groups in Nigeria, has established a number of housing needs and their requirements [10]. Housing should be seen as a lifelong necessity aimed at providing shelters, homes completely adapted to needs of humans and nomads alike which symbolize the values, desires, and adaptive capabilities in the built environment [15].

Furthermore, the active involvement of governments in nomadic housing provision will potentially decrease the impact of their activities and settlements on the environment particularly in the face of the global threats of climate change. Furthermore, the integration of green building materials and processes, sustainable practices, urban design and novel architectural concepts will potentially improve housing provision for nomads [16-21]. One of the most the promising architectural concepts that can be strategically integrated into future nomadic housing plans and policies is kinetic architecture. This is novel architectural concept in which buildings are constructed with mobile parts incorporated into the structure. The motion capability of the building is typically introduced to enhance aesthetics, respond to environmental or climatic conditions such as rain, heat and storms and or perform functions unattainable in stationary buildings [22, 23].

Therefore, the main objective of this paper is to evaluate the potential of kinetic architecture as a sustainable solution for addressing the housing challenges of the Fulbe pastoral nomads of northern Nigeria. It will review the current status of housing for nomads, architectural forms, and spatial organization of Fulbe housing in Nigeria.



## II. FULBE ARCHITECTURE

Architecture can be described as the “visual expression of man’s relationship with his environment.” This relationship can range from a situation of complete submission to nature where man assumes his life-style to the “given physical environment,” as the case with cave dwellers and tree-dwelling hunters and gatherers. This can often result complete mastery of the natural environment as evidence by advances in modern urban civilization where nature is almost totally subdued.

The pastoral Fulbe of Nigeria exist mostly at the lower extreme of his continuum. Consequently, their



Fig 2. Structural Framework of a typical Fulani Hut in a Nomadic Fulani Settlement

As a result, the pastoralist nomadic homes “*Wuro*” or “*Suudu*” are designed to be 3-4 meters in diameter and favorable to the ecological conditions in their environment. Each has two sleeping platforms on both sides with a tiny entrance. The bed on the left hand side belongs to the wife, while the right hand side is for the husband. The nomads associate order in every sphere of their endeavor.

One of the major factors that influence the organization of space amongst the Fulbe community is the east west orientation. The pastoral Fulbe largely believe that west is synonymous to front, while east is backing [24]. At the back of every camp, there is a curved back fence made from tree branches. This belief would keep off hyenas and also deflects any other attack on the cattle. The women with their bed shelter spaces are provided in front of the back fence (towards the East end) and the domestic hearth ‘*lite Suudu*’. All these constitute the

‘*suudu*’ or the home. The youth are allocated spaces to keep vigil on the cattle against intruders. A calf

settlements and house forms vary depending on the degree of mobility or the groups’ level of sedentarisation and the resources available at the given site. However, Fulbe nomads are typically averse landownership and permanent sites. Consequently, they place a premium on structures that can be dismantled easily or abandoned depending on the building resources and level of mobility. This concept is typified by the structures in Figures 2 and 3. Furthermore, *Stenning* observes that this concept is also shared by the Wodaabe of western Bornu [24]. Studies by *Kawuwa* in Gombe described different types of pastoral Fulbe houses comparing architectural and engineering knowledge to ensure robustness of the structure [12, 25].



Fig 3. A typical Fulani Hut in a Nomadic Fulani Settlement

rope is used to demarcate the wives area from the general area. Coral fire is kept to keep the animal warm.

Apart from the North-South orientation; there also exist the North- South quasi-orientation reflects the seniority level of individual within the compound. For example even among the wives who occupy the East end of the compound, the most senior wife places her bed shelter at the most Northerly end, while the next one closer to her and further down. Under this arrangement it is easy for the senior wife to be identified based on the position of her shelter in the compound in a similar manner, under a more general setting, where there are more, than one in the family has his hut located at the most Northerly end, while the next in the rank come closer to him and down the trend like that to the South. However, there are some slight changes to this culture, for example, in a study carried out by *Sa’ad* [26] in Jega village of Gwandu area the Sarkin Fulani of the camp had his camp at the center of the village, against the popular North end. However, his son (the crown prince) had his hut directly to the North end of him, while the other

notable chiefs in the village had their own next to the son (crown prince) while the cattle are generally enclosed in pens located West of the camp.

### III. HOUSING NEEDS OF THE NOMADS

The dynamics in the standard living of a man over the ages have numerous effects on the housing and the environment. These changes therefore call for constant checks on housing conditions and requirements of the people for the purpose of keeping them up to acceptable standards. As this exercise is carried out, the housing needs of the community within the settlement would naturally surface. The importance on the survey of housing needs of a community cannot be over emphasized.

The inexperience displayed by various nomadic communities towards housing as manifested in their general life-style is often misinterpreted as lack of need for shelter. The fact that it is the needs of the herd (pastoral nomads) that basically determine the size and distribution of local groupings as well as the pastoralists themselves. This assertion spells out the fact that at least there is a housing need somewhere to accommodate the herd vis-a-vis the herders. The generality of the environment therefore constitutes the housing environment. Lansing [27] defines a housing environment as one that establishes a sense of well-being and satisfaction of to its population through characteristics that may be physical such as housing style and condition, landscaping, available facilities; social in terms of friendliness of neighbours, ethnic, racial or economic composition; or symbolic based on sense of identity, prestige values. In the same vein, Awotona [28] went further to conclude that the ultimate satisfaction of the users is the only real test of success in any housing environment.

In general, it can be concluded that housing needs seek the maintenance of equilibrium in the provision and distribution of housing quality and quantity within a particular period of time and at a particular range of population. Judging from this, it can be inferred that housing need is more of a social consideration and little on the economic side. This is corroborated by studies which posit that comprehensive housing policy cannot be formulated without the critical study and appraisal of the housing needs particular for upward mobile communities like nomads.

### IV. TYPOLOGY OF NOMADIC HABITATS

To understand the housing needs of the nomads, it is important to first define the term "nomad" and its relationship with "nomadism". It 'as a way of life of a group of people in search of their means of subsistence thereby moving from place to place with their culture and in search of scarce resources [1, 2]. The nomads here are 'without a fixed home', 'search for means of subsistence' and have 'movement cycle along a directed course'. Having defined nomadism in reference to this research, one can then proceed to identify their housing needs.

Many scholars expressed the fact that many people can hardly identify their true housing needs [28]. This is related to the dynamics of developments surrounding man in his socio-economic and cultural life-style. However, *Doxiadis* [14] maintained that to understand the man's housing needs; we should endeavour to understand the natural state of man's needs in general before being specific on the housing need. This implies that man's housing need can easily be derived from his general needs. If we have to apply such approach, then we need to embark on an extensive analysis of the nomads needs.

Characteristics of nomadic habitats vary to a large extent with the typology of nomadic activities carried out by the group. For example, while the herders make use of the herd's product like the sheared hairs and skin in constructing their tents (Bedouin black tents), the hunting and gathering groups use more of the skin of the animals, as well as plants and grasses to erect their shelter. The fishing crews rely more on the shrubs around them to cater for their housing needs.

However, proposing housing for nomads requires a detailed understanding of their existing housing patterns. There is also need to understand some basic features of the nomads and their tents. First is the fact that amongst the nomads, regardless of their nomenclature, their perception of housing (tents) is acutely different from the sedentary population at least as long as they are still nomadic. This is because nomads spend a great deal of time living and working in open. For example, herding is naturally an outdoor activity like fishing at sea or hunting and gathering. Fundamentally, the nature of these activities requires that nomads spend more time outside than inside making them completely acclimatized to the weather conditions outdoors. Sedentary communities on the other hand, attach great importance to indoor environment where they carry out most of their activities. Nomads however consider clothing of greater importance to shelter. For example, the young boys among some desert nomadic communities are often sent off herding with nothing but the clothes on their back. Some of these boys sleep all the time in the open spaces with absolutely no shelter at all when the weather permits.

A study of most of the tents reveals that there are hardly any clear differences between indoor and outdoor environment as wind blows through the gaps that exist in the tent cover. Often there are rain leaks through the roof as snow falls, through the open smoke holes. The nomads really feel more at home under such dispensation because they feel more comfortable with their natural environment. This however, is not to relegate the importance of shelter to the nomads especially under the family set-up, as privacy is very important. Women, although carry out most of their domestic activities outside, they nevertheless spend sometimes in their tents, while the men spend their leisure time mostly under the tree. This is one of the reasons why tent is referred to as the women's property.

Another issue to consider is the sophistication of each tent. Under this consideration, one should not lose sight of the fact that every tent is supposed to be made of temporary or if possible mobile materials. Also, in view of the casualness of the nomadic tents, their appreciation and management of space is quite vital. This is so in view of the fact that the time of setting up and breaking down the tents, ease of mobility of tents, lightness of tenting materials as well as the frequency of usage, are some of the factors that limit the size of most nomadic tents spaces.

From here, one would examine the appropriation of limited spaces amongst the gender within homestead. This makes the study to identify some of the basic and most fundamental housing needs of the nomads. Another factor to be considered in this study is the flexibility of the nomadic tents. The report of *Giddings* in Feagre [29] on the *Kobuk Ekimos* in constructing a temporary shelter reflects the dynamics of the tent structure. The report described *Kobuk Ekimos'* tents are made to be so flexible that could withstand the emergency climatic changes experienced on the sea. Similar one to *Kobuk's* that was converted from a simple lean-to, to a wall tent, and further to a hemispherical hut, all within a day's voyage. The invariably indicated that the tent was able to satisfy the changes according to the wind, and temperature variations experienced just in that day. There are indeed several other groups of nomadic tents that display such a variable flexibilities in their designs which are very important. From all stated above, one can conclude that nomadic shelter is a temporary exploitation of natural resources as well as its expression of personality in a particular need.

In the absence of land limitations, the criteria of choice for housing site and settlement among the Fulbe varies with seasonal conditions. In the rainy seasons an upland site free from farmland which is often a source of friction with sedentary people is the prime choice. During this is the period, pastoralists tend cooperate fully with sedentary farmers in a symbolic existence hence conflicts with farmers are unlikely at this time of the year. However, in the dry season the criteria changes to proximity to natural resources such as water and grazing pasture for livestock. Other pertinent criteria include tree logging and land clearing which allows the cattle feed on stubs and other by-products of agricultural activities while helping to manure the fields for next season's planting.

## V. KINETIC ARCHITECTURAL STRUCTURES

This paper proposes kinetic architecture as a solution to the housing needs of the nomadic Fulbe. This is based on the premise that it is one of the most

the promising architectural concepts that can be adopted and integrated into future plans for nomadic housing and living spaces. The universal space solution as explored by *Mies van der Rohe* attempts to solve all functions with moveable partitions but very often actually satisfies none. It is evident that there must be a change in the design process. This major change will require subsequent mutations in other aspects of architectural practice. First of all, there must be change in attitude as architects can no longer live with the idea that the ultimate goal is create the monument of the ages. Whereas today buildings are typically designed to remain unchanged as static monuments, a building can be designed to be in different forms through time. This will suggest a major change in the design process and perhaps the starting point of the design in the field of kinetic architecture over time. Predicting exact changes that will occur in the set of pressures is an impossible task. Necessity is to predict the range of changes, which might occur.

Once the range of changes has been identified, it is necessary to design the architectural form, which can meet this range. Actually, the architect will not be designing one form but a whole range of forms. Rather than searching for an optimal solution the architect must test his solution for its capability to meet the range of pressure changes. The architect will be less concerned with the individual solution and more concerned with a field of solutions.

The kinetic designers like the Architect Santiago Calatrava and the Engineer Chuck Hoberman has helped pioneer the ideals of kinetic architecture. This concept organizes adaptable spaces into mobile structures mimicking living things with allowing a certain freedom of use. Thus the future structures become flexible creating a new space order that can be extended, modified and adapted to any further changes in the set of pressures. The future concepts from kinetic architecture will create buildings with mobile parts incorporated into the structure to enhance aesthetics and in the case of nomadic living respond to environmental or climatic conditions such as rain, heat and storms. As French theorist Eugene Viollet-le-Duc predicted that the new style of 19<sup>th</sup> century would consist of the 'honest expression' of the new building construction and materials like iron and glass [30]. In 21<sup>st</sup> century the new style will be more "kinetic". Kinetic design strategy allows new freedoms in the positioning of the structural elements and generates the principles like adaptable space. Many reasons may be found for employing kinetic systems in architecture that they are means to facilitate the adaptability of space. Such systems that are inherently deployable or transformable are ideally suited to accommodate and respond to changing pressures.

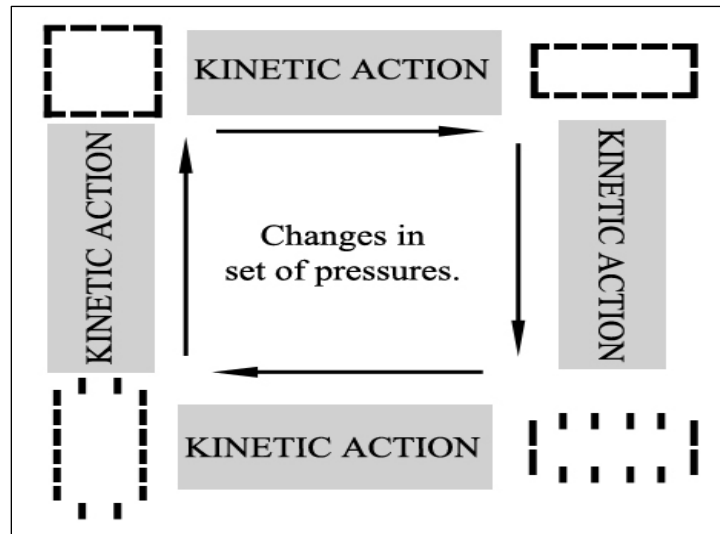


Fig 4. The relationship between the kinetic action and form.

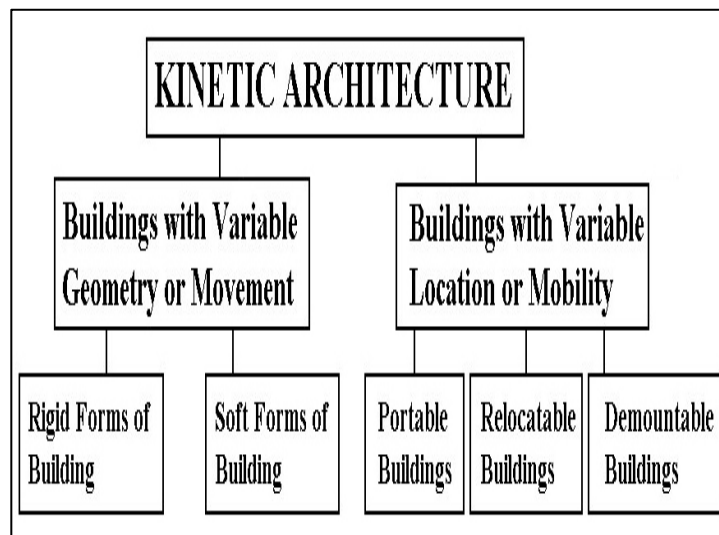


Fig 5. Major classifications of kinetic architecture.

However, analysis of various kinetic structures according to the classification demonstrate that kinetic architecture is an interdisciplinary study between architecture, structural engineering and mechanical engineering. This is an unexplored architecture with a new design approach for the application of kinetic structures to the buildings. It is a diverse field joining architectural design and engineering know-how. The new designer is concerned with the task of combining the structure provided by today's advanced engineering technology into an integrated whole through practical, functional, and aesthetic possibilities of contemporary materials. The kinetic structure solutions must consider in parallel both the design of the structure

according to the mechanism design principles and the selection of proper materials for covering.

## VI. CONCLUSION

The paper presented an overview of the potential of kinetic architectural as a solution for addressing the housing challenges of the Fulbe Nomads of Nigeria. The study also reviewed the architecture of the Fulbe, the typology and nature of their current housing as well as the factors to consider in proposing housing for the nomads. Lastly, the paper reviewed the fundamentals of kinetic architecture, its classifications and potential as a future solution to housing for nomads. Lastly, the paper concludes that the adoption of kinetic architecture into nomadic housing policy and planning can potentially results in



mobile, geometric and flexible buildings to meet the ever changing needs of nomadic people and reduce their impact on the environment.

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