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Adaptation of Traditional Construction Methods for a Sustainable Transition of the Dwelling (Case of Riads in Fez and Hanoks in Seoul)

Rime EL HARROUNI[1,3,a *], Iman BENKIRANE[2,b], Vincent BECUE[3,c]

[1]Euro-Mediterranean School of Architecture, Design and Urbanism, Euro-Mediterranean University of Fez Institution, Morocco

[2]Ecole Nationale d'Architecture de Rabat, BP 6372, Rabat Instituts, Rabat, Morocco

[3]Faculty of Architecture and Urbanism, University of Mons, Belgium

[a]rimaelharrouni@gmail.com, [b]i.benkirane@enarabat.ac.ma, [c]vincent.becue@umons.ac.be

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Abstract. Significant initiatives have been carried out by certain Moroccan organizations regarding safeguarding the Riads and Dars in Fez. Nevertheless, prior studies on the rehabilitation and restoration of traditional houses have only addressed the structural elements and thermal properties of the traditional environment, ignoring the spatial arrangement of the home and how it might be modified to better suit the needs and practices of modern residents. In reality, the production of newly effective technology involving structures and construction taking into account qualitative performances of the traditional dwelling has yet to be satisfactory specifically, as it is sparking a social discourse over the legitimacy of the traditional built design. This study aims to investigate the dissolution of the traditional dwelling in the medina of Fez to the degradation of the construction materials, and the safeguarding and rehabilitation Process of said dwelling. The main problem would be to answer: How to find the balance between the old and the new to provide a better quality of space? The defined method will take the form of a systemic comparative approach with the Korean model of dwelling called Hanok, to identify the similarities in terms of traditional methods of construction and the developed techniques used to transform said dwelling. For the sustainable development of these traditional habitat models, we need to establish specialized tools and a response plan for future Riads technology by comprehending consumer needs through: ongoing research on green technology to assess the usefulness of activities-oriented design in traditional homes and the improvement of natural materials in the rehabilitation process. Overall, this research aims to develop a specific scientific approach to transformation and adaptive reuse for sustainable habitability based on classifications of behavioral factors, technical factors, and contextual factors.

Introduction

The act of demolishing and rebuilding is carried out for the sake of efficiency, safety, and modernization. We might feel the need to reconstruct a building after a natural disaster or because of its insalubrity and contextual localization in an endangered area or on lands deemed obsolete, and inappropriate for modern life and the automobile. This demolition-reconstruction approach is still used today by the National Agency for Urban Renewal (ANRU), the Agency for the Development and Rehabilitation of the Medina of Fez (ADER), the Seoul Urban Solutions Agency (SUSA), and other national governmental institutions to significantly modify neighborhoods with a high concentration of low-income households and to upgrade and revitalize them.

If the reasons for destroying are not lacking, simultaneously the act of transforming invites us not to demolish but to think of sustainable ways to reuse and transform the traditional dwelling to

accommodate new activities and answers to consumer's current needs. Housing demands originate from a combination of biological necessities/opportunities/restraints and complicated contextual contexts in which the meaning and function of housing, and thus the notion of what quality living is and what the essential conditions for quality living are, might change. This is due not only to the fact that quality standards can differ (for example, in terms of the degree of insulation), but also to the fact that housing has various uses and meanings, and thus quality can be judged using quite different parameters [1].

In this research, we will be focusing on the Hanoks in Seoul and the Riads in Fez as two examples of institutions from Korea and Morocco that have taken crucial initiatives to preserve ancient dwellings. These days, the new lifestyles and altered household structures have caused the traditional dwelling to lose its identity and significance, which has resulted in the abandonment of Riads and Hanoks in favor of apartments and the degradation of those dwellings due to a lack of a comprehensive plan for appropriate rehabilitation and revitalization. Therefore, before advancing in an optic of transformation and reuse we have to tackle the traditional dwelling in terms of prospection of the restoration materials and identifying the old ingenious ways of constructions and new technologies that can be used to develop these models of habitat.

The method used is a comparative systemic approach based on the objective mode: The reflection here is turned towards the composition of forms, construction materials, orders, the topology of structures, spatial juxtaposition…

We will be focusing on the quality of space and comfort (thermal), sensorial perception…

This will help us identify the static physical and sensorial parameters of each model in their traditional state such as natural materials and sustainable traditional techniques that reflect an ingenious way of life and that we can upgrade with new technologies to solve thermal and structural problems of today.

Joined Parameters between the traditional Riads and Hanoks:

Physical Parameters:

-In Fez, the craftsmen used two types of earth, one yellowish, taken from near the neighborhood, in the place called 'Aïn Nuqbi, brought on the back of a donkey in baskets (Gwari), in dwarf palm, the other in compact gray blocks, is bluish and comes from the neighboring hills of the city in the direction of Sïdï Harazem. Once these large blocks of clay (Ndra) are transported, and crushed into small blocks (tuba), the mixing is done following a natural process[1] and after being impregnated with water, the artisans can move on to kneading and mixing in the workshop [2].

After the molding and smoothing operations, the Mzehrya tiles are shaped on the surface and polished and reworked to receive their final shape and are ready to be baked for the first firing (Zellige).

The rectangular pieces of Bejmât are 14,5cm long by 5 cm wide and 2,5 cm thick, and used mainly for paving patios following a process similar to the manufacture of Zellige. The difference here lies in the mold that affects the rectangular truncated pyramid shape of the Bejmât.

To summarize, construction ceramics abound in traditional Dars and Riads from the Merinid period, and they continue to play an important role in Fez today.

[1] The crushed blocks of clay are discharged into a circular pit (zaba) dug into the ground in the shape of a cup with the edges reinforced with large round pebbles as well as the bottom which is paved with pebbles. Water is then brought in by means of metal pipes. On the wall opposite the water inlet and at ground level, a small channel leads the liquid to this special pit of 2.20 m in diameter and 0.60 m in depth. While the water fills the basin, the mixture will stay like this for one to two days, the time necessary for the pieces to disintegrate by themselves and be ready for kneading.

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The walls are either in Pisé, less than a meter wide, or in earthen-baked bricks, and 40cm thick. The thickness and height of these walls provide good thermal inertia, which is important given the temperature and weather properties of the region.

To reinforce these walls, Wooden chaining could be used the stringers are sometimes coated with plaster to prevent crumbling due to humidity. Fig. 1 shows a section of Dar Lezrak with all the decorative and structural elements found in a typical Riad in Fez.

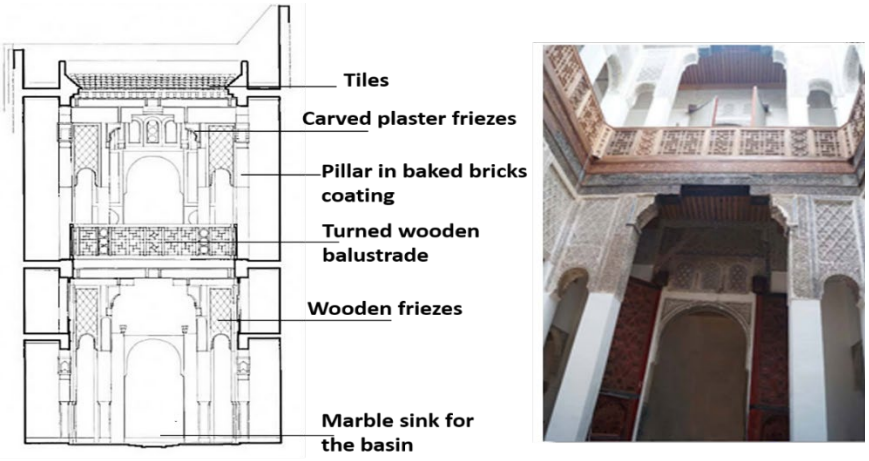

Figure 1: Section of Riad Lezrak in Fez

In a similar way, the transformation of the natural soil using traditional techniques also becomes part of the Hanoks construction process and depends on the condition of the soil. For sandy ground, the existing soil is compacted with water, and in the case of clay soil, steel ash is sprinkled and then compacted. If the distribution of soil particles or the proper input ratio of steel ash is quantified and standardized using the plate-breaking technique, which is a Hanok foundation method, it becomes possible to construct a foundation that is both nature-friendly and as strong as a concrete foundation [3]

Soil is an ideal building material for Hanok construction because it has excellent humidity control and ventilation, and is easily available.

Clay kiln-baked tiles were commonly utilized as roofing materials. For walls, Jeondol (전돌은) was manufactured by baking easily accessible soil at a high temperature, making it robust and resistant to fire and cold, thus compensating for a variety of drawbacks and inadequacies of the primary building materials, wood, and stone. That way we could find two types of walls in Hanok, simbyeok, and stone brick walls (Fig. 2). Other than aggregates, plastering the walls involves raising lattices and applying fodder, chopped straw, combined with mud to prevent the mud wall from splitting and makes it more adhesive [4].

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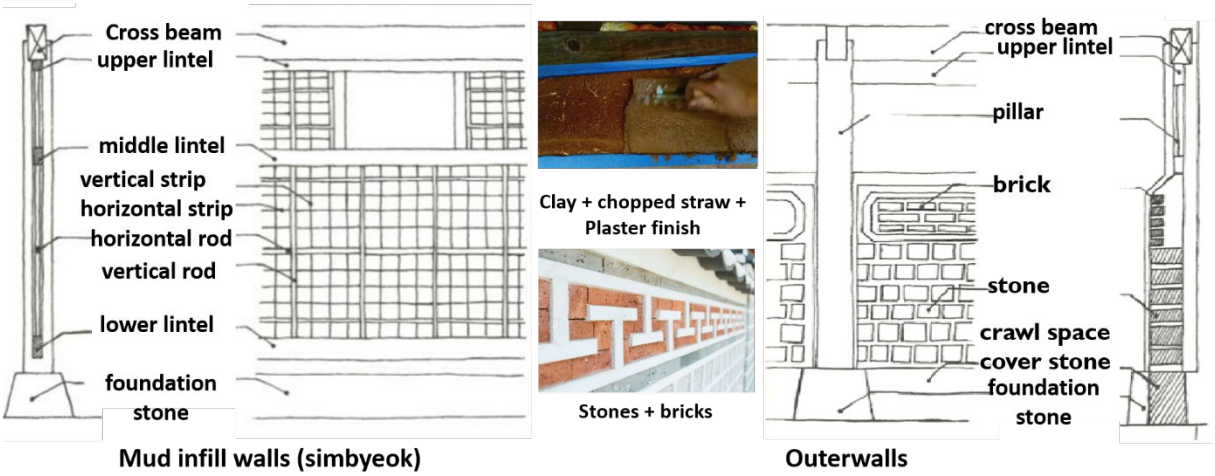

Figure 2: Types of walls in Hanoks

As for woodwork, in Hanoks, Cornerstones and flags receive almost all of the internal load, while walls play the role of partitions receiving only a slight load. Roof tiles are a common structural method. Three layers of flat roof tiles are laid, and round roof tiles are placed on top followed by the one placed for the curved ridge. Two types of purlins are used: Square purlins were used in lower-class homes and round ones were used in upper-class homes. As for round columns, they were restricted from being used in common residences and were typically used in royal palaces [5]. So here, we can see that there is a cultural and social significance even to the materials and structural elements used.

Both models of dwellings also present an architectural design that has remained mostly unchanged in terms of core shapes for several centuries and that responds to ornamentation reflecting nature, using mostly geometric and floral repertory.

Overall, wood is responsible for structural resistance and holding the house's shape but is also used in both models as a decorative element to emphasize the cultural aspect of each historical context. Soil is reported to be used for roofs, walls, and floors to suit the needs of the living environment. The roof soil is in charge of insulation and heat storage, the wall soil controls humidity and deodorizes to create a pleasant and healthy living place, and the floor soil is mixed with spheres to act as a heating function via thermal radiation. Stones and bricks are used as a means to prevent fires from spreading from one residence to another [6].

Table 1 concludes all the natural materials used in both dwellings.

Table 1: Material and their area of use in both Riads and Hanoks

Division	Riads		Hanoks	
	Materials	Area of Use	Materials	Area of Use
Soil	Earthen baked bricks, Lime, glazed bricks	Walls, Patio Covering, Stairs, curved tiles, earthenware tiles (zellige)	Earthen baked bricks, Lime, Pisé	Roof , Wall
Stone	Marble, limestone (fessala), Granite, Brick shaped Stones	Floor Covering, Door Frame, Bassin's Edges, Wall, Roof	Granite, Roofing Tile (Gi-wa), Brick shaped Stones	Cornerstone,foundation Stylobate, Wall,Door, roof
Wood	Cedar wood	Framework,Eaves, Doors,Windows, balcony railings, Walls, alcove arcades (Bhou),Framed ceiling	Pine	Eaves, Doors, Gong-po, Pillar, windows, wall, Decorations, Framed Ceiling
Grass	-	-	Rice Straw	Roof, Wall
Paper	-	-	Han-Ji	Windows
Metal	wrought iron	Door's Grids, Windows, Decorations	Bronze	Wall, Decorations, Windows

In both traditional dwelling models, the wooden structure defines the galleries and a hierarchical organization of spaces that express sequence, rhythm, and openness traits.

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For Hanoks there is a specific unit for length and width called Kan of 간(間) that considers human behavior and sensibility as a measure. The size of the 간(間), which is the basic concept for all spatial arrangements in a Traditional Hanok, is 3x5=15 cheok (≒4.5m), and there are rules of 3x6, 3x7, 3x8, depending on the status (Fig. 3).

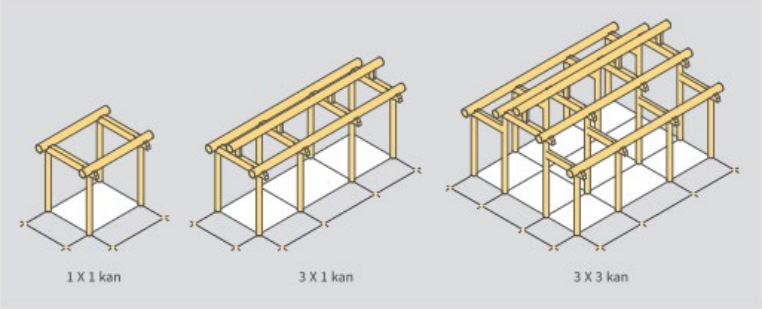

Figure 3: Concept of Kan 간(間)

Here, the number 3 represents the number of heaven, earth, and human universes, and 5 is the average human height. The cosmic number 3 and the human number 5 meet and become the basis for building a house set as the middle universe. The basic module of the 간(間) is functional and comfortable for human life and by juxtaposition to other modules it becomes a room and a house. Unlike the Western spatial perception system, which perceives objects in space and the remaining part is perceived as space, this concept of emptiness as a space is a traditional concept of dimension that perceives space centered on humans.

In the Buddhist culture and following the idea of Lao-tzu (157–141 BC), space is not defined only by walls that remain in a simple state of matter, nor is it defined by emptying that lacks axiomatic benefits. By studying emptiness rather than filling the space, it can be made into a more experiential and diverse space [7].

We find this rhythmic succession in the arcades composing the galleries of the riads, each time defining a space around the patio (iwan, loggia…) (Fig. 4). Most of the time the arcade constitutes an odd number but we can't take this observation as a generality to see if there is deeper cultural meaning behind it. But the resemblance with the Hanoks would reside in the balance between the void and the matter, and the modularity of the spaces generated by the structure.

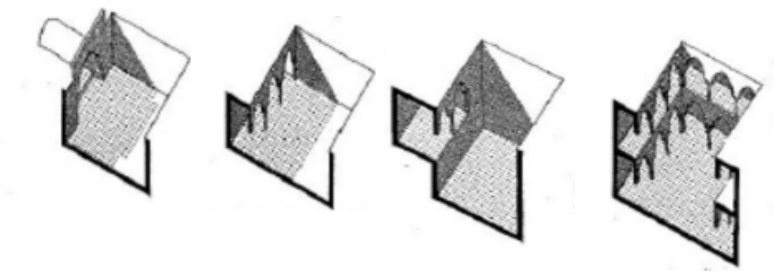

Figure 4: Type of Spatial organization around the Patio

The difference would be in the height and the number of floors constituting each dwelling. The traditional Hanoks mostly have one floor because there was no solution in the past to replicate the andol (natural floor heating) system in a second story.

Whereas Moroccan Riads could go up to three stories, each one usually accommodating a generation of family.

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Sensorial Parameters:

For sensorial parameters, we will focus here on comparing the techniques in each model of dwelling to provide thermal quality. In Moroccan Riads and especially during winter, walls and roof ceilings should be coated with an additional thermal insulation layer of 50-30 mm using for example wood wool or mineral wool [8]. Air penetration is another crucial component of comfort, particularly day ventilation, which helps to enhance the interior temperature in the winter. The Patio transforms a one or two-facade building into a four-solar orientation architecture. It provides natural light, creates an open private space, and helps control the building's thermal behavior (Fig.5)

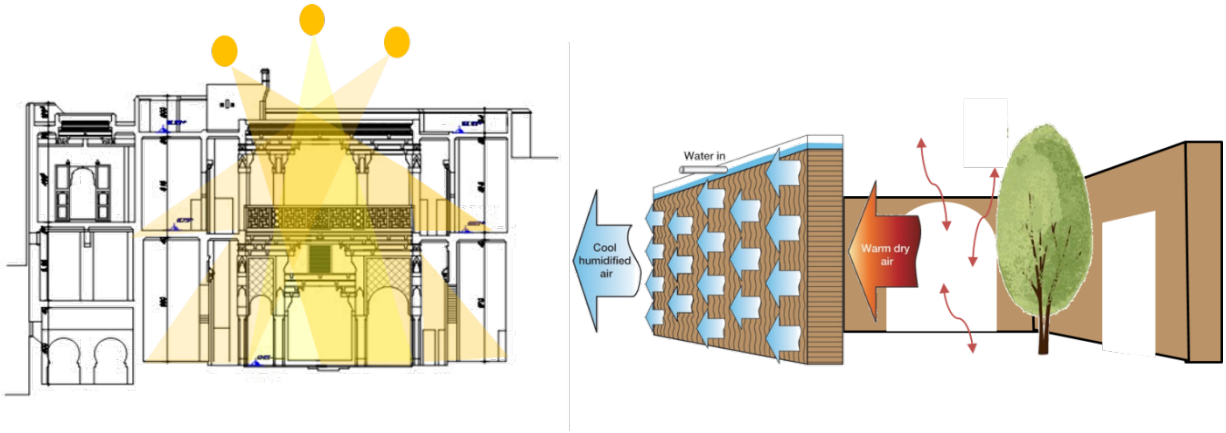

Figure 5: Thermal properties of the Patio inside a Riad

Like in the Riads, the patio helps for cooling the space inside the Hanoks, but the additional feature here would be the Ondol, This Korean floor heating system transfer the heat from the fire of the furnace through the flue channel and warms the stone prop above, so that the heat reaches the floor of the room (Fig. 6).

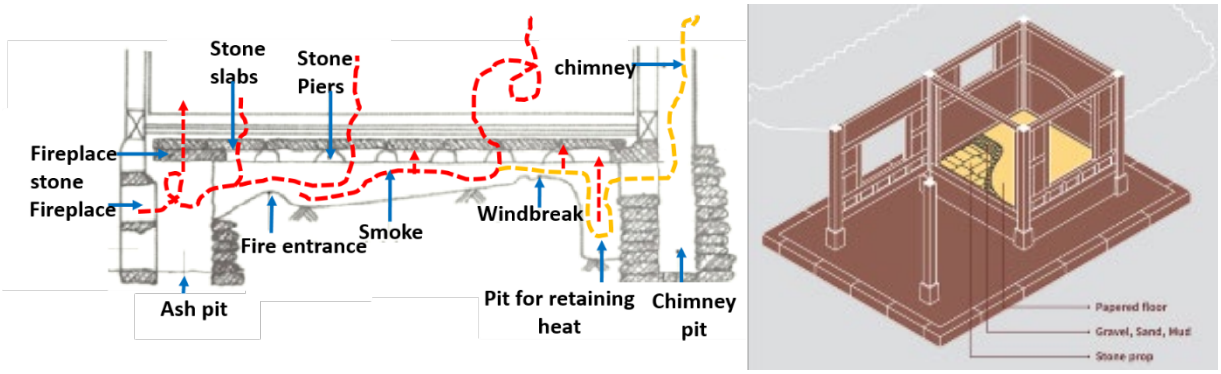

Figure 6: Traditional Korean Heating System (Ondol)

Current Rehabilitation and Revitalization Techniques for Riads and Hanoks:

Morocco has developed over the last decades a great experience in the field of the rehabilitation and Reconversion of traditional architecture. Its experiences were, in most cases, initiated by the Ministry of Culture within the framework of projects relating to World Heritage sites, and monuments or buildings classified at the national level. However, it is generally more a heritage approach of monumental restoration than a real revitalization [9]. That mostly involves restoring the waterproofing of the roof terraces, changing the coating of the walls, replacing the floors and certain load-bearing logs for the structure, and expanding some rooms to accommodate new activities.

Among the architectural systems conceived to adapt to new ways of living, we can find some new technologies added to the original traditional framework of the Hanok, to improve air

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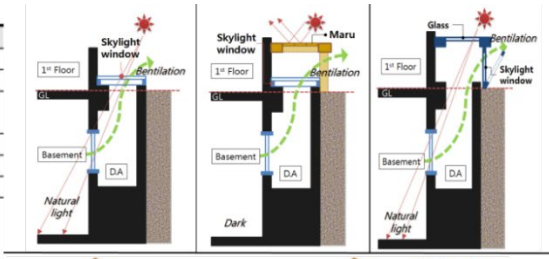
ventilation, and entry of light while providing thermal insulation thanks to smart windows, roof skylights, trusses, roof lightweight body [10]. Reinforcement of the wooden structure, as well as creation of built-in wardrobes and variable wall alcoves as well as built-in storage in Maru (wooden floor) to provide flexible use of space and storage as the family grows.

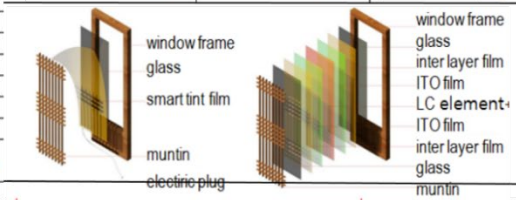
Table 2 shows the new techniques developed in the Korean Hanoks, which can serve as models to implement in the Moroccan Riads.

Table 2: Necessary functions and new technologies developed in Hanoks.

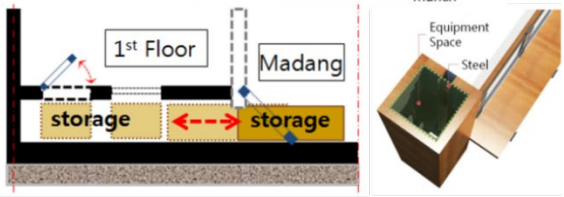
Parts		Necessary Function
Roof		Lightweight roofing
		Modern features introduced
		Features of the eaves
		Storage using the ceiling(attic)
Body	Wall	Modern process interior work
		Modular wall, Variable wall
		Storage using the wall(closet)
	Window	Reflect traditional windows design
		Sunshine regulation introduced
	Floor	Storage using the floor(Maru)
Stylobate & Basement		Storage using the stylobate
		Natural lighting
		Ventilation system
Outdoor		Activate the function of the Madang
Equipment		Equipment flush mounting type
		Utilizing a variety of lighting
		Air-conditioning Installation
		Fire-safe equipment
		Disaster prevention system



-Developing the Ventilation system,
-New entry of light



Introducing ingenious materials:
-Smart windows
-Reinforced structure



Modular structure:
-Storage
-flexible spatial functions

Discussion of the Results and Conclusion:

While taking into account the different modes of comparative evaluation and the specific characteristics of each traditional dwelling such as physical, behavioral, and sensorial parameters, we find the common settings for Riads and Hanoks :

Riads are located in the historic medina of Fez, which is a UNESCO World Heritage Site.

- Typically found in narrow, winding alleys and streets that are inaccessible to vehicles.
- Often located close to important landmarks, such as mosques, madrasas, and markets.
- Designed to be inward-facing, with a central courtyard and rooms surrounding it.
- Often feature geometric and floral decorative elements such as mosaics, intricate tile work, and carved wood.
- Associated with Islamic cultural tradition.

Hanoks are Located in traditional Korean neighborhoods in Seoul, such as Bukchon Hanok Village and Namsangol Hanok Village.

- Often located on hillside locations with views of the surrounding landscape.
- Typically designed with an inward-facing courtyard or garden.
- Built using natural materials such as wood, stone, and soil, and often feature a tiled roof.
- Often feature geometric and floral decorative elements such as roof tile, woodwork, and furniture.
- Associated with Confucian and Buddhist traditions.

Although there are some variations in construction methods and structural design, Hanoks in Seoul and Riads in Fez Medina both aim to create a quiet, private area in the middle of a busy metropolitan setting, and they frequently include natural and mineral features like gardens and

fountains/streams. Additionally, they both place a high priority on maintaining traditional architectural designs and cultural traditions.

Both housing styles have multipurpose rooms that allow the space to adapt to changing demands and activities as well as the inhabitant's future needs.

Both have an inward-facing layout with open spaces like the patio and Daecheong that offer cover during the hot summer months to keep the house cool while using natural heating sources during winter.

The two habitat models honor the idea of intimacy and gender segregation by restricting the Riad's external apertures and offering a wing specifically for women (Anchae/안채), which is located far from the Hanok's main entrance.

The following measures were taken to enhance the traditional homes' sensory quality:

-Lengthening the structure along the axis that runs parallel to the north and south façades.

-North-south orientation, or the long axis from east to west, is advised for buildings.

-Moderating the openings' size to a medium range, 25–40% of the total wall surface.

-Upgrading the insulation in the walls and roof and suggesting lightweight or low-temperature alternatives for these building components.

To improve the physical aspect of the traditional dwellings observed:

-Improved construction techniques, including seismic reinforcement and bracing elements

-Develop a modular structure for flexible spatial composition and activities

-Innovative use of architectural elements of the dwelling for storage

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