
West Facade of the Museum/Lajos Kossuth House

Sustainable and traditional technologies in Kutahya historic houses and their contribution to circularity: the case of Lajos Kossuth house

Betül Ankaralıgil[1], Gülşen Dişli[2]

Department of Architecture, Necmettin Erbakan University. Turkey.
Email: [1] bankaraligil10@gmail.com, [2] disli001@umn.edu

Abstract: It is important to preserve historic buildings in their original conditions, not only to protect building integrity but also to sustain Traditional Knowledge Systems. As stated by ICCROM, those Traditional Knowledge Systems play an important role in the conservation and management of heritage. Among them, building service systems including heating, cooling, ventilation, lighting, drainage, and their architectural construction technology help sustain heritage buildings and extend their life cycle with a minimum level of energy demand. Passive survivability means also contribute to comfort conditions, opening new scenarios for the designing of contemporary buildings. Hence, in this research, first, traditional Kutahya houses were examined in terms of their construction, technology, and architecture. Then, among them, Lajos Kossuth House, dating from the 18th century, has been chosen as an example to investigate its traditional building service systems in more detail from the point of circularity in construction, their contribution to circular economy, Cradle to Cradle (C2C) strategies, and design for adaptability principles (DfA). It is observed that they are mostly in a well-preserved condition in terms of both function and character-defining features. However, after 1982, during its refurbishment work to be used as a museum, some of its original details, especially the ones related to waste and clean water were destroyed. To be able to sustain and protect the rest of the original service systems and related architectural construction details in this case study building, they should first be documented, well defined and their recognition should be increased to serve as a model for the maintenance of similar building systems. In addition, it might be possible to transfer the knowledge of those passive survivability means and circular construction principles to contemporary buildings.

Keywords: Traditional Knowledge Systems; Lajos Kossuth House; building service systems; sustainability; circular construction; traditional Kutahya houses.

Cite as: Ankaralıgil, B. and Dişli, G. 2021. 'When construction was linear. Analysis of the energy sustainability of social housing in Spain (1939-1989)'. *VITRUVIO - International Journal of Architectural Technology and Sustainability*, 6(1), pp. 92-109. https://doi.org/10.4995/vitruvio-ijats.2021.15452

1. Introduction

Traditional Knowledge Systems (TKS) are "the principles, processes, and techniques, tangible and intangible practices of a community's heritage lasting over time" and to be able to sustain the local history, they should be given great importance during the preservation of historic buildings (Wijesuriya and Court, 2020; Umezu, 2020). Among them, building service systems, namely, heating, cooling, ventilation, lighting, waste, and clean water systems, play a vital role in the longevity of building integrity. Yet, studies in this field are rather limited. In Turkey, especially monumental buildings, including Turkish baths and historic hospitals were examined partially, and a limited number of traditional Turkish houses were analysed in terms of their service systems (Disli et al., 2019; Disli and Ozcan, 2016; Disli and Celik, 2016; Disli, 2014; Ozcan and Disli, 2014; Disli and Ozcan, 2014). Whereas investigation of traditional houses in terms of their entire service systems and their contribution to circular economy and circular design principles gives an idea about the comfort conditions, passive survivability means, technology, and construction techniques in history, and at the same time, the adaptability possibilities of traditional systems may inspire the current needs of contemporary buildings. Hence, this study aims to analyse certain specific aspects of architectural construction details related to building service systems in historic Kutahya houses, focusing on their ecological nature and energy efficiency, and then among them, a historic house case dated the 18th century was examined in more detail. With this goal, the research included in-situ analyses of historic houses in Kutahya to observe the architectural construction details serving for passive heating, cooling, ventilation, and drainage, as well as to evaluate them in terms of energy efficiency and their contribution to circular construction, circular economy, C2C, and DfA principles, that were never pointed out in previous studies. Field surveys, conducted four times in November and December 2020, form the basis of the research. Oral communication with the museum officials, archival research on Conservation Board, travellers' accounts, and literature surveys on both traditional Kutahya houses and the case study building were the other methods applied during the study. Survey drawings and old photos of the building dated to 1954 were obtained from the dissertation studies of Lami Eser and compared with its contemporary condition (Eser, 1955).

Kutahya is located in the Central Western Anatolia of the Aegean Region in Turkey. It serves as a transition zone between the coastal line of the Aegean Region and the central part of Turkey. It constitutes about 1.5 % (11,875 square kilometres) of the whole area of Turkey lands. According to Köppen Trewartha climate classification, terrestrial temperate climate is predominant in the city, such that it is warm, dry in summers, and cool in winters (Turkish State Meteorological Service, 2018). The average annual temperature is 10.5 C°, the hottest months are July and August, and the coldest months are January and February. Rainfall is observable mostly in winter, spring and autumn. The average annual rainfall is 565 mm. The wettest and driest months are December and August, respectively, and the prevailing wind direction is north (Kütahya Provincial Directorate of Environment and Urbanization, 2017).

In literature, there are studies related to traditional Kutahya houses. Among them, Eser's research is an important contribution (Eser, 1955). In this study, it is clearly stated that in traditional Kutahya houses, main body walls were either constructed with wooden structure filled with mud-brick or with adobe masonry and plastered with 2-3 cm thick straw-mud plaster (Eser, 1955; Koçlardan, 2019). Aras et al. examined wooden ceilings of Kutahya houses located in the central part and Emet district (Aras et al., 2005). Yalçın's study focuses directly on Lajos Kossuth House (Yalçın, 2019). He examined its spaces and exhibition items in detail. According to him, the main reasons for the destruction of traditional Kutahya houses were; lifestyle change, the need for regular care, and high restoration costs. Gökdemir et al. similarly focused on the very reasons for structural deteriorations in traditional Kutahya houses (Gökdemir et al., 2014) and Yazkaç investigated the change in those buildings from 1940s until today (Yazkaç, 2018). Though there are some alterations and deteriorations, the houses still contribute to circularity with their adaptive reuse or continued use-value by reducing material extraction from the environment and by forming close bonds with the society.

There are some measures taken by the Turkish Government for the preservation of historic buildings, among which is the Law of 2863 on the Protection of Cultural and Natural Assets dated 1983, is the most relevant and common one (Official Gazette, 1983). There are also some important Principle Decisions. In Principle Decision 660, dated 1999, the assets designated as Cultural Property were classified into two groups: 1st Group Buildings were defined as the ones that constitute the material history of the society that must be preserved with their historical, symbolic, memory, and aesthetic qualities. 2nd Group Buildings, on the other hand, are defined as the assets that reflect and contribute to the local lifestyle and identity of the city they are located (Turkish Republic Ministry of Culture and Tourism, 1999). Historic houses are mostly considered in the second group of buildings. Construction techniques of traditional houses generally depend on the location, climate, social status, and culture of the inhabitants and it is important to understand their way of construction for their useful adaptability and applicability to contemporary buildings (Umezu, 2020). Religious beliefs, lifestyles, traditions, and economic power of the inhabitants also affect plan type, façades, dimensions, decorations, and material usage in those buildings, as in the case of traditional Kutahya houses (Eser, 1955). Hence, to achieve sustainable and creative design for future generations, during their preservation, it is important not only to maintain the integrity of the individual building itself, but also the service systems, architectural construction details, and traditional materials and techniques that the building contains.

2. Sustainable and Traditional Technologies and Circularity Principles in Kutahya Historic Houses

Traditional buildings are already energy efficient in their very nature. They were constructed in respect to the nature and environmental conditions of the region they were located with little or no energy demands. In traditional Kutahya houses, similarly, energy-efficient, sustainable, and circular design arrangements are observable. Moreno et al. identifies the five circular design strategies as; "design for circular supplies, resource conservation, multiple cycles, long-life use of products, and design for systems change." (Moreno et al., 2016). Similarly, traditional Kutahya houses were all constructed with minimum resources of local, natural materials such as earth, stone, and timber, easily available from the region, which can be extracted and returned to nature again without causing any harm to the environment. They are also durable materials extending the life cycle of the houses. Reuse, repair, maintenance, and upgrade works also extend their utilization and increase the relationship between the users and buildings, thus an "emotionally durable design" and a sharing system is established (Campbell, 2009).

From the accounts of a famous Turkish traveller Evliya Celebi, who lived in the 17th century, it is understood that there were houses all covered with an earthen roof, water cisterns, warehouses for the storage of wheat, and fountains in the inner and outer citadel of the city, and in lower parts of the fortress. In that period, the houses had façade projections and camelbacks mostly facing to the north at the second floors and had large courtyards with greenery irrigated via water ditches connected to the nearby stream. In the 17th century, there were in total twelve public baths for regular cleaning purposes, forty public fountains, eight water sources, and thirty private fountains (Kahraman, 2011). Yet, at present, only the Küçük Hamam, Elvan Bey Hamam, Rüstem Pasha Hamam, Lala Hüseyin Pasha Hamam, Kemer Hamam, Şengül Hamam, and Yeni Mahalle Hamam are existent, three of which are out of use. Water is still quite abundant in Kutahya, and some of the public baths and fountains are still in use. Accounts of Evliya Celebi are informative about the natural material usage such as earthen roof, climate- sensitive construction in houses such as facade projections and camelbacks facing to the north and large courtyards, and water usage and sources in the 17th century Kutahya houses.

Because of religious necessities, in traditional Kutahya houses, spaces related to clean and wastewater systems, such as toilets and ablution spaces, were generally located in the courtyard or outer sofa, rather than inside the building, and originally made of either timber or mud-brick material. Toilets were mostly lined up to one of the walls of the courtyard or built as a separate unit. The ones located inside the house were either later additions or in the form of projecting spaces. For instance in Ali Pasha House, the toilet was made of timber construction walls and located in the courtyard, and similarly, in Bandımzade House, the toilet was disguised inside the thick stone courtyard wall. In Hacı Efendi House, the toilet was located in the courtyard, as well. Thus, they were easily connected to the city sewage, or in the form of cesspools that could easily be cleaned. There were also some projecting balcony-like semi-open spaces in the first or second floors of the houses, located on the outer sofa, mostly close to the sitting area/kiosk (*taht/köşk*) for the ablution or handwashing purposes via portable water carried with ewers. Wastewater was discharged in those spaces through wooden waterspouts connected to the floor drains, and then to the courtyard. Thus, it was possible to water the greenery in the garden with this recycled water. Defterdar Mansion, Hacı Efendi House, İsmail Hacı Çakır House, and Halit Yargılayan House were some examples of traditional Kutahya House, which had original ablution spaces (Eser, 1955) (Fig.1). In some other cases, there was a fountain in the courtyard (Eser, 1955). Water ditches (Kahraman, 2011) and pools were also observable for both the provision and collection of water and for cooling purposes on hot summer days. Bathing cubicles located inside the wooden cupboards in each room and public baths in the vicinity were the primary spaces for cleaning the body. The bathing cubicles were in the form of projecting spaces on the facades, and their floors were originally covered with zinc. The wastewater was drained with free-fall from the floor drains on the projecting walls, and directed to the city sewage with the inclined ground surfaces (Eser, 1955). Clean water for bathing in houses was provided from either public fountains or wells, private fountains, and water ditches in the courtyard. Ewers, water jugs, and buckets were the main portable devices to carry the water. Thus, especially in waste and clean water systems, as part of circular design strategies, design for multiple cycles are observable

Figure 1 | Interior (left) and exterior (right) views of an original ablution space protruded from the facade (a guesthouse in Siner Village, Kutahya).

enabling longer circulation of their multiple uses such as water recycling and rainfall capture.

In the original urban texture of Kutahya, the wooden eaves of traditional houses on two sides of the streets were rather large that they nearly touched each other, thus provided shadow in hot summer days and prevented wind and cold in winter times (Eser, 1955). It was so common to construct single-story houses elevated from the ground. In this case, the main floor was raised from the ground level as much as possible to provide enough light, sun, air, and panorama for the above living spaces, or the ground floor was used for secondary functions, such as barns, haylofts, warehouses, stalls, wheat and storage depots (Eser, 1955). Thus, an indirect heat gain was possible from the heat of the animals. Compressed earth was the common material used on the floors of the spaces in the basement (Eser, 1955) and those spaces had no window openings, or had only small ones for ventilation, and were generally buried to the earth at one or two facades at least. Thus, it was possible to keep the food fresh much longer by using the cooling effect of the surrounding earth. Another detail for food protection in traditional Kutahya houses is in the form of a projecting wooden window called "süt dolabı" in the local language, perforated on three sides, mostly located on the northern facades of the houses (Fig.2). Thanks to the fast and intense airflow on three sides, the food is kept cold and fresh for long hours in those projecting cubicles. This protrusion can also be in the form of a wire mesh cover on three sides, and called "sütlük" in the local language (Davulcu, 2010). A similar detail is observable in the form of projecting facades in living spaces. In some of the rooms, there are approximately one-meter protrusions mostly facing towards the street and to the north direction, with window openings on the front and two sidewalls (Fig. 2). Diwan (wooden sitting benches with cushions on) surrounds the periphery of protruding walls at the interior. This special sitting arrangement in the room is preferred especially for its highly ventilated and cooling effect.

Mud-brick was a common construction material especially on the main body walls of the houses either in bare form or as an infill material inside the timber construction (Akok, 1963). Brick was another infill material. The clayed soil in mud-brick units is useful for heat gain in winter times

Figure 2 | Views from "*süt dolabı*" in a traditional Kutahya house (top), and types of protrusion areas in living spaces; carried on floor beams (top-right), with flat coated (bottom-left and center) and coated with curved ornaments (bottom-right)

since it warms up late and keeps the heat for a long time (Eser, 1955). Eser stated that there were no special spaces for cooking inside the houses, instead, a small cooking place in the courtyard or one of the rooms in the house was allocated for that purpose (Eser, 1955). In traditional Kutahya houses, doors, windows, or chimney extensions of the furnaces were the main ventilation arrangements of the spaces. Besides, outer sofa plan type (semi-open terrace-like space, towards which all the rooms were opened) directed to the open courtyard also helped the rooms ventilated, and wooden lattices, balconies, raised sitting areas, and semi-open iwans in the outer sofa, were all special arrangements providing well-ventilated spaces. There were also solutions for shading in traditional Kutahya houses. For instance, window blinds, wooden shutters, high masonry, or mud-brick courtyard walls, especially in the south sides, all served shading purposes (Eser, 1955) (Fig. 3). In dark hours of the day, artificial lighting elements such as candles and beeswax

Figure 3 | Wooden shutters for shading for privacy purposes in traditional Kutahya houses.

on candlesticks made of brass, silver, gold, and amber were used (Yüca, 2019).

The living spaces were heated with built-in furnaces on the walls. To prevent the excess of cold when the furnaces are not in use, their front face is covered with sliding metal or two-sided wooden covers. According to archival registers, dated 1761-63, in the 18th century traditional Kutahya houses, wood and charcoal were the most common fuels used in furnaces for heating the space (Yüca, 2019). Braziers were also supplementary portable devices used to heat the space. In traditional Kutahya houses, there are pitched roofs, gable roofs, or earthen roofs. In gable roofs, the triangular wall surfaces on two sides are mostly covered with timber called "pedavra" to protect the mud-brick walls from rainfall (Koçlardan, 2019). Pitched and gable roofs are mostly covered with tile, and in some rare cases with timber (Eser, 1955). The first row of tiles at the very end of the eaves are lined side by side with their grooves in upside direction, thus, they serve as gutters. The width of the eaves changes between 0.40-1.30 m. Beneath the wooden eaves and protrusion areas in living spaces are covered either with straight timber, left bare, or with curved timber (Koçlardan, 2019) (see Fig. 2).

Considering the all above descriptions, Kutahya houses can be evaluated to meet substantially the three main principles of cradle-to-cradle (C2C) building; "there is no waste, energy can be renewed as it is used, and cultural, innovation, and species diversity is available" (Mulhall and Braungart, 2010). For instance, the HVAC of the houses was mostly provided with natural, renewable sources with the correct direction, location, and design of spaces and architectural elements, thus it was possible to supply clean air and water. Natural, local construction materials were used beneficial for human health and the environment. Originally earthen roofs were used that retain moisture, and special architectural solutions were preferred (pools, diwans, *köşk*) that improve air quality and passive cooling. Similarly, "sütlük/süt dolabı" that uses cross-air ventilation principle, "pedavra" application protecting the sidewalls, and roof tile covering with upside grooves that collect rainwater can all be considered as C2C innovations of traditional Kutahya houses.

3. Lajos Kossuth House

Lajos Kossuth House is approximately one km away from Kutahya city centre, located in Borekciler District, Macar Street. Kossuth House, originally known as Hüseyin Hamdi Aydın Mansion (Yalçın, 2019), was started to be used by a Hungarian family, representative of the Hungarian War of Independence, in the mid-19th century. The exact construction date of the house and its construction duration remains uncertain. Yet, according to an oral interview with Kutahya Museum Directorate, the building is dated the 18th century, so it is the only surviving civic architecture example in Kütahya, reached today from that period (Yalçın, 2019). The building has an outer (open) sofa, which was a characteristic feature of that period. It has three floors comprising of the basement floor, winter floor, and summer floor, from bottom to top. Its courtyard is surrounded by masonry walls and is entered via a double-wing door on the north side. There is a sloped passage towards the inner courtyard from that entrance. All three floors are open to the inner courtyard either via their outer sofas supported with wooden posts (at the winter and summer floors) or sunken courtyard in front of the basement floor. There are three rooms on the summer floor, and four rooms on the winter floor. There is a later period addition of a guesthouse and a lodging building on the east side of Lajos Kossuth House. They have similar façade arrangements with the original building. It was started to be used as a museum on September 19, 1982, and continues this function (Turkish Republic Kütahya Governorship, 2021). On special days of the year, the Hungarian bureaucrats hold memorial services. Thus, the building serves for sharing and multifunctional uses as part of Design for Adaptability (DfA) principles defined as "intentional strategies for supporting multiple potential uses", and enhances social coherence between different societies, which overlaps with the "R1-rethink" strategy in the circular economy (Potting et al., 2017; The American Institute of Architects, 2020). In addition, the clothes, utensils, equipment, and furniture in the exhibition, all provide information about the life and period of Lajos Kossuth, thus contribute to the revival of Hungarian traditions in a formerly Turkish house. Since the museum has some architectural and memorable significance for the community, DfA also helps preserve those values by protecting historic heritage for all. Building service systems in Lajos Kossuth House are examined under five headings and explained in detail below.

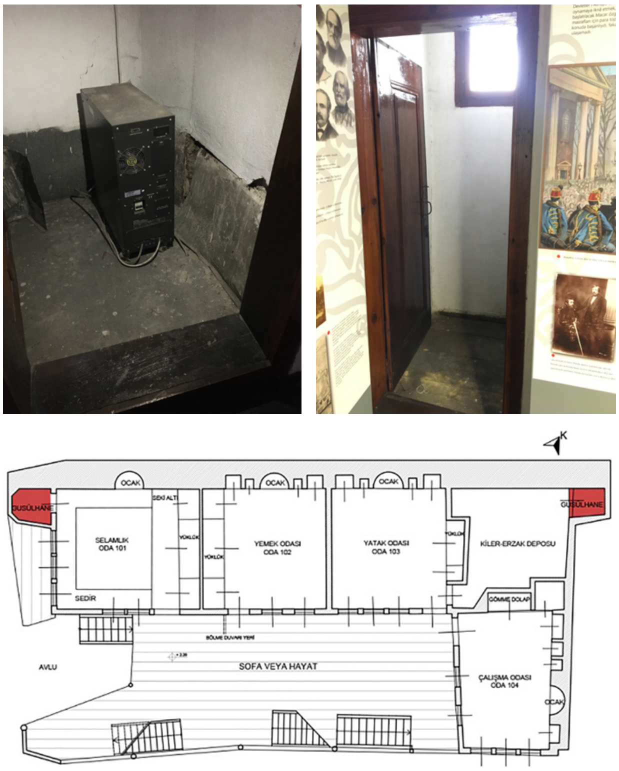

Figure 4 | Bathing cubicles in rooms 101 (top-left) and 103 (top-right) on the winter floor with lead covering on the ground and on the wall up to ≈20 cm height to prevent the splash of water to the wall surfaces during the bathing and their location on plan drawing (bottom).

3.1 Waste and Clean Water Systems

In Lajos Kossuth House, the toilets are later additions, located on the southeast corner of the building on top of each other, and at present can be reached from the outer courtyard or stairway. During the refurbishment process, instead of complete demolition of those unoriginal parts, they were adapted to be used as either a depot or toilet again. Originally, it was probably in the courtyard connected to the sewer pipes carrying wastewater mostly made of terracotta, sealed with a special mortar. Since, originally, there were no taps; people probably flushed the toilets with pitchers of water after each use and cleaned themselves with the water carried with portable devices. Yet, at present, neither the original sewer system nor the terracotta pipes are observable. There are also bathing cubicles as protruding spaces on the east and west sides of the north wall and inside the wooden cupboards of the rooms (Fig. 4). In Lajos Kossuth House, the bathing cubicles are located in rooms 101, 102, and 203, and in room 201, there was also a bathing cubicle inside the wooden cupboard, which is not existent at present. Those cubicles, most of which were closed during

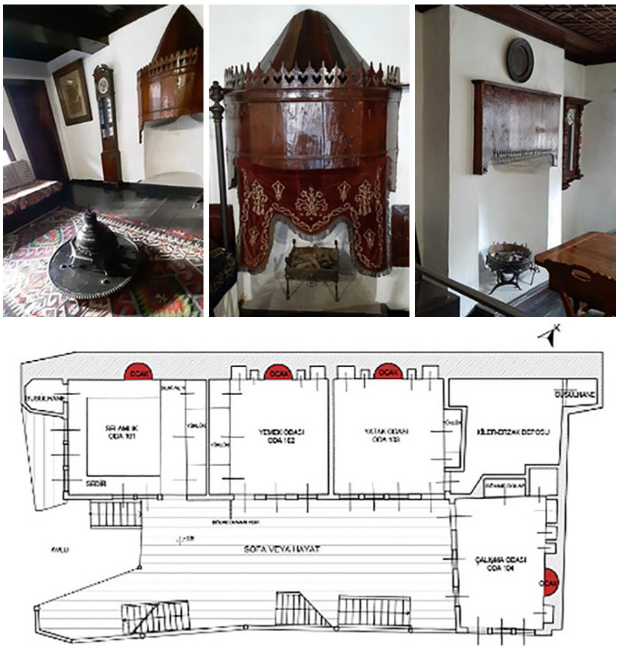

Figure 5 | Furnaces and braziers in rooms 101, 103, and 104 on the winter floor (top-from left to right) and plan drawing showing their location in the building (bottom).

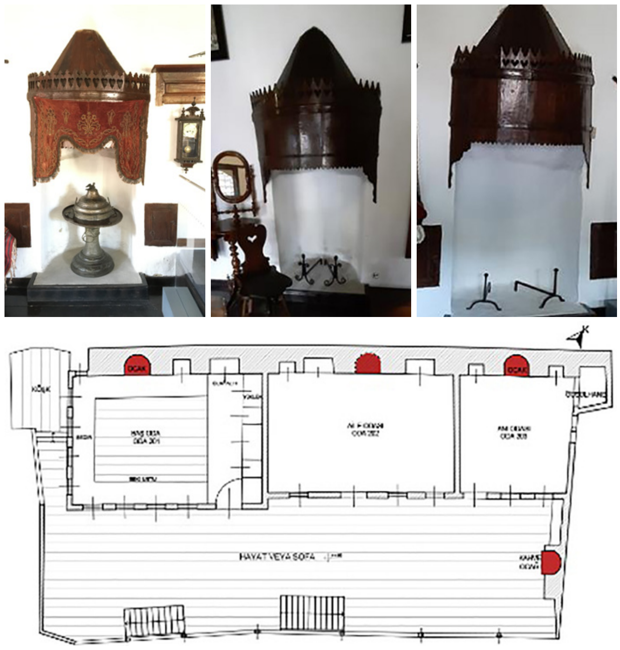

Figure 6 | Furnaces and braziers in rooms 201, 202, and 203 on the summer floor (top- from left to right) and plan drawing showing their location in the building (bottom)

the refurbishment works, were used as bathing spaces, with wooden seats, small lighting windows, and floor drains for the discharge of wastewater. Clearwater, on the other hand, was provided with portable devices such as water jugs and ewers heated on the furnaces. Though the bathing cubicles are out of use at present because of the new function of the building, they still exhibit and retrieve the traditional bathing culture of the region in history, to the visitors of the museum, thus promote circularity in the social aspect. In addition to bathing cubicles, nearby public bathhouses were so often used to clean the body. Since there is no room to be a kitchen and for washing the dishes or clothes, the courtyard might have been used for those activities. Besides, there might have been a well inside the courtyard to provide water for those cleaning activities. There are no taps inside the house, but the fountain on the entrance courtyard wall must have served for the provision of drinking water. At present, there is an ornamental marble pool in the courtyard that might have been used for the collection of rainwater directed from the roof and ground surfaces and for cooling purposes on hot summer days, but not in its original location. Thus, originally, it served for water reuse and different purposes thus foster R1-rethink and R3-reuse strategy in the circular economy (Potting et al., 2017). Barn, warehouse, hayloft, and depots are located on the basement floor entered via a sloped floor surface from the sunken courtyard, and a drain is located on it to prevent ponding of water. Since there were no taps for bathing or cleaning inside the house, the fountain or well in the courtyard might have been used for cleaning activities, and this historic culture contributed partially to water management, such that less water could be used than needed because of portable devices. In the circular economy, it overlaps with the R2-reduce strategy by consuming less water.

3.2 Heating Systems

In Lajos Kossuth House, built-in wall furnaces and braziers were used for space heating (Fig. 5, Fig. 6). There are furnaces and braziers, still observable, in all living spaces. The furnaces are located on the outer and thicker walls of the rooms, so they do not form any projections on the facades. Their inner surfaces are generally covered with large wooden hats or sliding metal covers to prevent the cold when they are not in use. Stoves and Dutch ovens, on the other hand, started to be used in Kutahya only after the second half of the 19th century with the arrival of Hungarian refugees (Özdemir, 2018). In addition to those direct heating elements, there are also some indirect applications serving for the warmth of the spaces and the users, as well. Among them, the proper direction of living spaces plays an important role, such that the longer façade of the house lies along the southwest-northeast direction, and the north façade was built thicker without any openings to prevent the effects of strong cold winds

Figure 7 | North (left) façade of the building without any window openings and raised wall of outer sofa (right).

blowing from the north, thus increasing environmental resilience (Fig. 7). Privacy was the other reason, such that because of religious considerations, this facade facing the street was left bare without any openings (Eser, 1955). Most of the windows and doors of the building are directed towards the south to benefit from the sunlight at an optimum level, but not let the cold northern winds. Besides, floor heights show variations to allow winter and summer usages. On the winter floor, to prevent the heat flow, the height of the living spaces is built lower (2.60 m.) than the summer floor (3.20 m.) (Fig. 8). Wooden railings at the floor level and coatings at the ceiling level on the outer sofa of the winter floor were kept higher than the summer floor to keep the heat inside. Thick mat coverings, rugs, and diwans also contributed to the warmth of the users (Eser, 1955). Akok also mentions the existence of separate space in the courtyard with an oven in it, used both for cooking and for cleaning (Akok, 1963), but today it is not observable. Thus, the use of such simple, flexible, durable, and low-maintenance systems and architectural solutions (proper direction, winter-summer rooms with varying heights, furnaces with wooden hats/sliding metal covers, thick walls, no window openings on the north side) for the heating of spaces contributes to resilience benefits of DfA strategy by withstanding the natural forces and climate change.

3.3 Cooling Systems

Cooling systems/elements/solutions were an important part of old buildings both to keep the food fresh and to cool the body. In Lajos Kossuth House, the proper direction of spaces, sloped topography of the land, and special devices such as pottery vessels and wooden granary were all used for cooling purposes. Natural building materials such as mud-brick, timber, and stone also provided cool interiors during the summer. Barn, warehouse, hayloft,

Figure 8 | Views from the summer floor (top-left) and winter floor (top-right) with a section drawing (bottom) showing their heights.

Figure 9 | Depots, and wooden wheat storage room (above), terracotta jars for food storage (below).

Figure 10 | Exterior (top left) and interior (top right) views from the semi-open kiosk (*köşk*) on the northwest corner or the outer sofa on summer floor.

and depots are located on the basement floor buried in the ground on the north side. Thus, those spaces were kept cool both by using the proper direction of spaces and the cooling effect of the earth during the summer season. In addition, there is an observation window between the two depots to control the level of grain without opening the doors so often, thus keeping the indoor heat of the spaces at certain levels (Fig. 9). The east wall of the depots does not have any openings, and they have only small lattice windows for ventilation purposes. The food inside was kept in pottery vessels (Fig. 9). Today, barn, warehouses, hayloft, and depots are used as inventory/storage rooms where museum collections are stored and the objects in the exhibition are changed at certain intervals. Thus, those discarded spaces have been re-functioned suitable to the "R7-repurpose" circularity strategy (Potting et al., 2017). There are also some special solutions for cooling purposes on the summer floor in Lajos Kossuth House. On this floor, there is a semi-open kiosk (*köşk*) on the Northwest corner of the outer sofa, elevated with two stairs (≈0.50 m). It has wooden lattice windows on the west and north sides, thus speeding up the airflow and cooling the space, even on hot summer days. The wooden lattice windows were also used for privacy considerations and to determine the guests without opening the door. Increased floor height (3.20 m) and lower wooden railings on the outer sofa, provided the fresh air to reach that floor easily, and thus keep the space cooler (Fig. 10).

3.4 Ventilation and Lighting Systems

In Lajos Kossuth House, ventilation is mostly provided via windows, doors, and chimney openings of the furnaces.

Figure 11 | Exterior and interior views of windows on the winter floor (bottom-left) and summer floor (top and bottom-right) 1: small special opening arrangement used for the ventilation of the room quickly, 2: decorated plaster window at the second row.

Figure 12 | Ventilated diwan details

For lighting the rooms, similarly, there are one or two rows of windows at different levels. They have various opening arrangements depending on their location. On the winter floor, the rooms have only one row of windows, located just above the diwan (seating units), and have two levels of casements opened on two sides. When the room is needed to be ventilated easily and rapidly, the bottom casement openings are preferred (Fig. 11). However, on the summer floor, the living spaces have two rows of larger windows, compared to the ones on the winter floor. The first level windows are rectangular and their casements are opened as a whole on two sides. The top-level of windows is made of decorative plaster with glass infill (Fig. 11). On the summer floor, the outer sofa is ventilated on the west side through a straight opening at the top level of the wall, and there is a row of lattice windows just beneath that opening. Thus, the outer sofa is well ventilated both on the south and west sides. Ventilated diwans are also observable on this floor (Fig. 12). In room 201, the wall, through which the wooden seating (diwan) lies, does not sit directly on the wall of the bottom floor (room 101) instead, it was constructed overflowing just as the width of the diwan in front of it with additional wooden beams supporting this wall. Thus, 3-4 cm air openings are created beneath the wooden seating in room 201, providing ventilation in this summer room. Ventilated diwans, winter and summer room applications, and various window arrangements might be considered as C2C innovations in the ventilation systems. Similarly, the chimney extensions of furnaces, observable in all living spaces, both provide smoke evacuation when they burn and are useful construction details for the natural ventilation of spaces for part of the year, thus support intentional multiple uses and contribute to environmental benefits of DfA strategy. All the rooms are opened to a semi-open outer sofa, thus constant air circulation is provided when the doors and windows are open. On the basement floor, the depots are ventilated and illuminated via small lattice wooden window openings. There is a granary raised on wooden feet just in front of the depot on this floor. This raised platform of wooden feet both keep the grain well ventilated and protect the grain from moisture and water during rainy days. In addition to natural lighting, there are also devices for artificial lighting in Lajos Kossuth House. In the house, there are some wall niches or decorative elements in wooden cupboards to locate the oil lamps or candles, some of which are still observable (Fig. 13). They are either in the form of wall niches called "şerbetlik" or projecting surfaces called "lambalık/kandillik". Decorated wooden cores of living spaces were also used for hanging oil lamps at the centre of the room to provide lighting during the night. The small niches called "tembel gözü" located on two sides of furnaces, were used for storing some small equipment such as kindling and match to ignite the wood and candle (Fig. 13).

3.5 Roof Drainage Systems

Large wooden eaves (≈1.30 m) and hipped roof covered with clay roofing tiles are the main roof drainage elements in Lajos Kossuth House. At present, drainage is supported with metal downpipes and downspouts (Fig. 14).

Figure 13 | Niches on wooden cupboards used for holding candle/candlesticks/oil lamps in room 101 (left) and 201 (right).

4. Discussion and Conclusion

In traditional Turkish houses, sustainable, economical, and environmentally responsible solutions and principles are observable. Bektaş specifies those principles as; "compliance with life, nature, and environmental conditions, realism (rationalism), internal-external harmony, attitude, ease of construction methods, conformity to human size, local material usage, and flexibility" (Bektaş, 2020). Traditional Kutahya houses, similarly, have energy-efficient, ecological, and sustainable construction and design solutions compatible with circular economy, construction, C2C, and DfA strategies. Their local and natural material selection, the direction of spaces, topography and land use, and construction details, all building service systems and architectural construction details/elements related to those systems have been examined first, in traditional Kutahya houses, and investigated in more detail under five headings in an 18th century case study building, Lajos Kossuth House. In traditional Kutahya houses primary results obtained from in-situ observations and literature/archival surveys are as follows:

- Natural and easily available local material used for the construction of houses and building systems,
- Traditional construction techniques such as earthen roofs, facade projections, camelbacks, projecting wooden windows for cooling and storage of food,
- Climate-sensitive designs,
- Cleaning in bathing cubicles with a minimum amount of portable water,

Figure 14 | Views from the large wooden eaves, downspouts, downpipes, and tile covering (top and bottom).

- Ablution spaces with floor drain connected to water-spouts overflowing to the courtyard, thus usage of recycled water for
- the greenery in the garden,
- Existence of water ditches, fountains, and pools in the courtyards for both the provision and collection of water and for cooling,
- Well-ventilated semi-open and closed space arrangements such as diwan, *köşk*, outer sofa,
- Use of shading elements such as window shutters/blinds, high courtyard walls,
- Development of special architectural details for natural ventilation, cooling and heating of spaces such as bottom-ventilated diwans, the summer and winter rooms with varying heights,
- Use of built-in furnaces and their chimney extensions for the heating and cooling of spaces depending on the season,

In Lajos Kossuth House, similarly, DfA, C2C, circular economy, and circular construction strategies are wisely implemented. Its adaptive reuse as a museum is analogous to the R5-refurbish strategy in the circular economy (Potting et al., 2017). During the rehabilitation works, the building preserved its original design with minimal space disruption and with rather a few new material usage that extends the useful lifespan of the abandoned building, enhances the public access, revitalizes and sustains the traditional, cultural, and social values of the neighbourhood, and revives traditional architecture, while achieving environmental benefits. Even the collections exhibited, mostly belong to the historic building, which contributes to smart material and building use. In addition, thanks to the adaptive reuse of an existing traditional house instead of new museum construction, noise pollution, and sidewalks/streets disruption have been avoided, waste management and low-carbon options are provided, and it takes less time than building new. They are substantial wins for both the community and valuable for all participants (owners, architects, suppliers, contractors, heritage experts, and artisans) included the in rehabilitation process. Similarly, as part of circular construction, with its socially responsible use as a museum, it creates social opportunities by providing collaboration between the visitors, museum directorate, and local community, which prolongs the social and socioeconomic relationship between them. Since it has not been demolished allowing a vacant lot, or simply not abandoned, it also has the potential to increase neighbourhood security, support continued use of resources, and reduces the environmental impacts, risks of blight, litter, and crime. Thus, all those DfA, C2C, and circularity strategies and management systems in terms of rehabilitation help preserve distinct historic, social, cultural, and economic values of the case study building. It is observable that the building was well suited to the weather conditions of the region and the topography that surrounded it. Construction materials were also dependent on the local environment, such that, the north and east walls of the building, looking to the street, were made of thick layers of wood construction filled with the earth at the upper floors and stone at the basement, which provided warmer indoor conditions for the dwellings. In addition, the use of local, durable materials, simple, robust structural systems, respect to the topography, and design adaptation to the existing climate increase resilience characteristics of the building for the environment. There are no window or door openings on the north side of the house, fully protecting the building from the prevailing wind direction. Thanks to the thick walls, inside the rooms are surprisingly warm, besides, low-rise winter room applications, furnaces, and braziers as mounted and portable heating elements/devices help keep the indoor temperature at ideal levels. Wooden seating benches/diwans surrounding the rooms on two or three sides were covered with thick wooden clothes providing additional warmth. There are also small, decorative niches on the wall surfaces or wooden cases to hold the oil lamps for both light and heat. Thus, together all those details kept cold air out and warm air in Lajos Kossuth House. While it was necessary to cope up with the cold in winter conditions, it was also needed to develop techniques to cool and dry the building in hot and rainy seasons. Therefore special solutions such as long wooden eaves, allowing rainwater to run off the house without brushing the walls, outer (open) sofa plan type facing to the courtyard with a pool in it, and ventilated diwans have been developed. These special designs developed against weather-related risks, passive design methods, use of local materials, cutting raw materials, flexible heating, cooling, ventilation, and lighting applications are important individual circular construction strategies in “planning for long term climate change and design for energy efficiency” (Foster, 2020). Thus by preserving and exhibiting all those ecological, energy-efficient features, the building both contribute to promoting human well-being and reviving traditional construction techniques by influencing the people who use and visit it.

At present, the building is given a new function and started to be used as a museum, and during this refurbishment process, some of its original details related to building service systems were lost, yet the building envelope and material characteristics were mostly preserved. Hence, it is important first, to define and increase the recognition of those systems, and then maintain their survivability through a holistic approach during any restoration work, such that it is important to preserve not only the façade and plan characteristics but also such small details as building service systems in any conservation work.

Heating, cooling, ventilation, lighting, waste and clean water, and drainage systems observable in case study building and traditional Kutahya houses represent the circular economy, circular construction, C2C, and DfA strategies that might inspire future generations. Especially, in the case study building, environmental, resilience, community, and economic benefits of those strategies have been clearly revealed. They are mostly both ecological and sensitive to human health, and their sustainable construction techniques might be transferred to contemporary houses with present creative design solutions to improve the quality of life with minimum energy demands. For instance, traditional mud-brick construction might be adjusted to today's comfort conditions with gypsum additives. Thus, there will be a minimum need for regular care. Similarly, original earthen roofs might be replaced with green roofs, as an ecological solution to contemporary life. Thus, it will be possible to minimize the heating and cooling loads, protect the underlying roofing/insulation layers, and create aesthetic and healthy living spaces. Projecting facades and wooden window protrusions located on the northern sides, smart-use of topography, and shading solutions, long wooden eaves, ventilated diwans, use of semi-open (outer sofa, *köşk*) and open spaces (courtyard with greenery and pool), planning varying ceiling heights for alternative seasonal usages are all sustainable strategies that might be applicable in modern designs. Thanks to these and similar adaptations, it is possible and an urgent necessity to create healthy and comfortable spaces, and to ensure effective use of energy in rational and scientific ways. Hence, for further studies, it is advised to search for further possibilities of the applicability and adaptability of all these passive survivability means and circularity strategies to contemporary environments.

References

Akok, M. 1963. 'Kütahya ve Uşak şehirlerinin eski evleri'. *Türk Etnografya Dergisi,* 6, pp. 5-17.

Aras, R., M. Budakçı and M. Erbüyür. 2005. 'The Ceiling of the traditional Turkish houses in Kutahya and Emet'. *Journal of Polytechnic,* 8(1), pp. 81-86.

Bektaş, C. (2020) *Turkish house*. YEM Publishing, Istanbul.

Campbell, J. 2009. 'Design for (emotional) durability'. *Design Issues*, 25(4), pp. 29-35. https://doi.org/10.1162/desi.2009.25.4.29

Davulcu, M. 2010. 'Kütahya Yöresi Halk Mimarisi Geleneği Üzerine Bir İnceleme'. In: *Kütahya Halk Kültürü Araştırmaları*, 22-51. Kutahya Valiliği, Kutahya.

Dişli, G. 2018. 'Analysis of ancient ventilation and illumination practices in Anatolian Seljuk and Ottoman hospitals and suggestions for their conservation measures'. *International Journal of Heritage Architecture,* 2(1), pp. 174-185. https://doi.org/10.2495/HA-V2-N1-174-185

Dişli, G. 2014. 'Sustainability of historic building systems: Anatolian Seljuk and Ottoman hospitals'. *APT Bulletin: The Journal of Preservation Technology,* 45(4), pp. 45-51.

Dişli, G. and N. Çelik. 2016. 'Heating system evaluation of an ancient Turkish bath; the bath of Suleymaniye Hospital'. In: *Proceedings Book of 12th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics*. Malaga, Spain, 2016, 1649-1653.

Dişli, G., Ş.B. Orhan and A. Duysak. 2019. 'Functional systems in historic houses: a historic house case in Konya-Ilgın'. *Journal of Art History* 8(2), pp. 407-435. DOI: 10.29135/std.589052.

Disli, G. and Z. Ozcan. 2014. 'Waste and clean water systems in Anatolian Seljuk and Ottoman period hospitals'. *International Journal of Academic Research,* 6(3), pp. 169-177. https://doi.org/10.7813/2075-4124.2014/6-3/A.23

Dişli, G. and Z. Özcan. 2016. 'An evaluation of heating technology in Anatolian Seljuk period hospitals (darüşşifa)'. *METU Journal of Faculty of Architecture,* 33(2), pp. 183-200. https://doi.org/10.4305/METU.JFA.2016.2.8

Eser, L. 1955. Kütahya evleri. PhD Dissertation, Istanbul Technical University, Istanbul.

Foster, G. 2020. 'Circular economy strategies for adaptive reuse of cultural heritage buildings to reduce environmental impacts'. *Resources, Conservation, and Recycling,* 152, pp. 1-14. https://doi.org/10.1016/j.resconrec.2019.104507

Gökdemir, A., C. Demirel and Ç. Kurt. 2014. 'Investigation of architecture and structural deterioration factors of historical Kutahya houses'. *Journal of Balıkesir University Institute of Science and Technology,* 16(2), pp. 39-50.

Kahraman, S.A. 2011. *Günümüz Türkçesiyle Evliya Çelebi Seyahatnamesi: Kütahya, Manisa, Izmir, Antalya, Karaman, Adana, Halep, Şam, Kudüs, Mekke, Medine*. YKY Publishing, Istanbul.

Koçlardan, P. 2019. *The examination of construction techniques of traditional Kutahya houses and conservation proposals*. Master's Thesis, Yıldız Technical University, Istanbul.

Kuban, D. 1995. *Türk Hayatlı Evi*. MTR Publishing, Istanbul.

Küçükerman, Ö. 1995. *Anadolu Mirasında Türk Evleri*. Publications of Ministry of Culture, Istanbul.

Kültür, S. 2011. 'Spatial analysis of toyhane in traditional Divriği Houses'. *Intercultural Understanding,* 1, pp. 39-47.

Kütahya Provincial Directorate of Environment and Urbanization. 2017. Kütahya İli 2016 Yılı Çevre Durum Raporu [WWW document]. URL https://webdosya.csb.gov.tr/db/ced/editordosya/kutahya_icdr2016.pdf (accessed 5 February 2021).

Manioğlu, G. 2007. 'Geleneksel Mimaride İklimle Uyumlu Binalar: Mardin'de Bir Öğrenci Atölyesi'. In: *VIII. Ulusal Tesisat Mühendisliği Kongresi*. İzmir, Turkey, 2007, 79-92.

Mulhall, D. and Braungart, M. 2010. *Cradle to Cradle Criteria for the Built Environment*. K. Hansen (ed.), EPEA, Duiven.

The American Institute of Architects (AIA). 2020. Buildings that last: design for adaptability, deconstruction, and reuse [WWW document]. URL https://content.aia.org/sites/default/files/2020-03/ADR-Guide-final_0.pdf. (accessed 10 April 2021).

Moreno, M., C. Rios, Z. Rowe, F. Charnley. 2016. 'A Conceptual Framework for Circular Design'. *Sustainability,* 8(9), p. 937. https://doi.org/10.3390/su8090937.

Official Gazette. 1983. Kültür ve Tabiat Varlıklarını Koruma Kanunu. Mevzuat Bilgi Sistemi. 1983 [WWW document]. URL https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=2863&MevzuatTur=1&MevzuatTertip=5 (accessed 3 February 2021).

Oğuz, B. 2001. *Türkiye Halkının Kültür Kökenleri 3: İnşa, Isıtma ve Aydınlatma Teknikleri*. Anadolu Aydınlanma Vakfı Publishing, İstanbul.

Ozcan, Z. and G. Disli. 2014. 'Refrigeration technology in Anatolian Seljuk and Ottoman period hospitals'. *Gazi University Journal of Science,* 27(3), pp. 1015-1021.

Özdemir, N. 2018. *Kadim Şehir Kütahya*. Kendi Publishing House, Kutahya.

Potting, J. Hekkert, M. P., Worrell, E., Hanemaaijer, A. 2017. *Circular economy: Measuring innovation in the product chain*. PBL Publication, The Hague.

Turkish Republic Kütahya Governorship. 2021. [WWW document]. URL http://www.kutahya.gov.tr/macar-misafirlerimiz-macar-milli-kahramani-lajos-kossuth-kutahyada-yeni (accessed 9 January 2021).

Turkish Republic Ministry of Culture and Tourism. 1999. (660 nolu İlke Kararı) Taşınmaz Kültür Varlıklarının Gruplandırılması, Bakım ve Onarımları. [WWW document]. URL https://teftis.ktb.gov.tr/TR-13918/660-nolu-ilke-karari-tasinmaz-kultur-varliklarinin-grup-.html (accessed 7 February 2021).

Turkish State Meteorological Service. 2018. Köppen-Trewartha İklim Sınıflandırmasına göre Türkiye İklimi [WWW document]. URL https://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari/K%C3%B6ppen-Trewatha.pdf (accessed 2 February 2021).

Ulukavak Harputlugil, G. and N. Çetintürk. 2005. 'Evaluation of thermal comfort conditions of traditional Turkish Houses: Haci Huseyinler House in Safranbolu'. *Journal of the Faculty of Engineering and Architecture of Gazi University,* 20(1), pp. 77-84.

Umezu, A. 2020. 'The adaptability of traditional knowledge systems to modern management in Japan: restoration, energy efficiency and disaster prevention'. In: G. Wijesuriya and S. Court (eds.), *Traditional Knowledge Systems, the Conservation, and Management of Asia's Heritage*. ICCROM, Rome, 189-198.

Wijesuriya, G. and S. Court. 2020. *Traditional Knowledge Systems and The Conservation and Management of Asia's Heritage*. ICCROM, Rome.

Yalçın, Ç. 2019. ‘The evaluation of Kossuth House in Kutahya civil architecture within the examples in the terms of fictional space analysis’. *Dumlupınar University Journal of Social Sciences*, Special Issue, March 2019, pp. 153-162.

Yazkaç, P. 2018. Ahmet Yakupoğlu’nun Resimlerinde Geleneksel Kütahya Sivil Mimari Örneklerinin Dünü ve Bugünü Üzerine Karşılaştırmalı Bir Çalışma. *Turkish Studies Journal,* 13(18), pp. 1409-1430. https://doi.org/10.7827/TurkishStudies.13882

Yüca, S. 2019. *No 2 Kutahya court records transferring to Latin characters and its assessment*. Master’s Thesis, Dumlupınar University, Kutahya.