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Article

Spatial analysis of sericulture and silk production in Southern Marmara Region

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ABSTRACT

Silk production has been one of the most fundamental industrial activities shaping the economic and cultural structure of Anatolia from 130 BC to 1453 AD. The Southern Marmara Region has played a central role in the historical process of transforming silk from raw material to finished product. In this context, traditional houses, workshops, cocooning facilities, and silk factories located in the Southern Marmara Region were studied to systematically identify and document the development of silk production structures in the region through the relationship between production processes and spatial organization. Within the scope of the research, the process extending from traditional residential-scale production to industrial factories has been documented considering field studies, on-site observations, and archival documents. This study, which adopts qualitative research methods, is supported by literature data, institutional reports, interviews with local people, architectural fieldwork, and architectural documentation data. Considering the data obtained, the architectural features of silk production structures in the region, their production processes, and the social and cultural reflections of this production have been examined within a holistic framework. In conclusion, this study analyzes the heritage of silk production from an architectural perspective, offering a scientific framework based on qualitative and empirical methods for the preservation and transmission of this unique industrial heritage to future generations.

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INTRODUCTION

Silk trade, a value that has influenced the world economy from 130 BC to 1453 AD (Sheriff & Akeje, 2021), spread throughout the world, and the Silk Road trade became a focal point that countries tried to control (Alkan, 2005; Altun, 2007). China is the birthplace of silkworm domestication and the origin of silk production. China's keeping its silk production techniques a state secret for over a thousand years triggered an intense desire in the Western world to unravel this mystery (Feltham, 2009). Simple silk extraction from cocoons and weaving were also first carried out in China. Silk production became an art in China, bringing

This article is based on a PhD dissertation examining the constitution and creative potential of Gilles Deleuze's philosophy of repetition in the context of Bernard Cache's architectural practice, and prepared by Nehir Sanrı Doğan under the supervision of Prof. Dr. Çiğdem Polatoğlu Serter at the Department of Architecture, Yıldız Technical University.

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fame and great profit to the country (Tuncel et al., 1995). In this context, silk can be considered as the high technology of the pre-Industrial Revolution era due to the production of this valuable fiber requires both biological knowledge and a complex processing art.

China's absolute dominance came to an end in the 6th century AD with the rise of knowledge that transcended borders. During the reign of Byzantine Emperor Justinian, two monks smuggled silkworm eggs from China to Constantinople inside hollowed-out canes, changing the course of global technology transfer (Mola, 2000). Silk production began in Anatolia around 550 AD (Boulnois, 2004). This secret operation reduced dependence on foreign sources for silk production and paved the way for the development of local textile industries.

The Silk Road and other routes connected to this road system have historically contributed to the economic development of the regions they passed through, raising the living standards of their people, while also serving as a bridge between Eastern and Western civilizations (Figure 1). This enabled many different nations to engage meeting, trade, and cultural exchange (Günel, 2010). Long-distance trade conducted via historical road systems has also led to cross-cultural transmission between different societies (Darkhan, 2016). The most important product transported by camel train trade was silk (Drijvers, 1994).

From the 14th century onwards, Bursa became a global center where raw silk from Iran was processed and marketed to Europe (Dalsar, 1960). During the Ottoman period, caravanserais and resting complexes along the Silk Road created the architectural infrastructure that ensured the safe transportation and storage of this valuable product (İnalcık, 1994). It is known that during the Ottoman period, silk fabrics were both produced in Bursa and largely marketed through these cities (İnalcık, 2008). Silk production in Anatolia was not only a craft but also an architectural program that directly determined the settlement pattern and building forms. Especially in the 15th and 16th centuries, the silk inns in Bursa are the most concrete evidence of how the centrality of trade and production intertwined

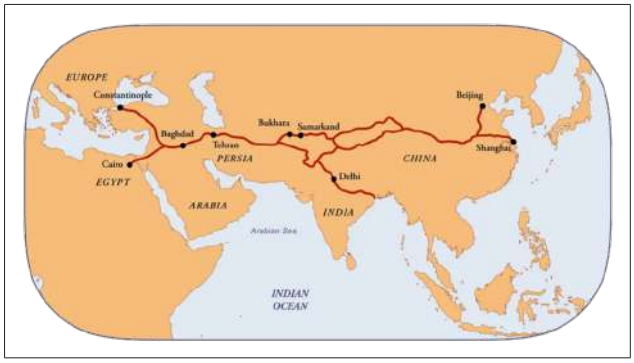

Figure 1. Silk Road (KE Adventure Travel, 2023).

with spatial design (Baykal, 1950). Access to high-quality fabrics, a symbol of luxury and status until the 18th century, was replaced by the ideal of inexpensive and practical clothing with the Industrial Revolution. In this process, textiles became not only an industry but also a locomotive connecting global trade networks, agricultural production, and technological innovation (Beckert, 2014).

The Historical and Economic Context of Silk Production in Southern Marmara Region

Sericulture is inherently dependent on mulberry trees, as mulberry leaves constitute the sole natural foods form silkworms. This dependence directly shapes the location and logistical setup of the production facilities (houses, cocooning areas, factories). In traditional sericulture houses, the lower floors or large halls are used as production areas. Mulberry trees are located right in the garden of the house or in fields very close to it. In rural areas, production begins in the raw material center where mulberry trees are most abundant. At this stage, the freshness of the leaves is vital; because mulberry leaves picked from the branch quickly wilt and lose their nutritional value (Başkaya, 2014). The placement of cocooning areas is such that it minimizes the distance of leaf transport, right on the edge of the mulberry groves or on the outskirts of the village. At the factory stage, live caterpillars are no longer involved in the process; instead, cocoons are processed. Therefore, the factory does not necessarily have to be physically close to mulberry trees. For the subsequent stages of production, the equipment located inside the structures is of great importance.

Examining the historical development of silk production buildings reveals that their spatial configurations were shaped not only by production techniques but also by the social and economic organizations in which they operated. The transition from small-scale, family-based production models to industrial organizations brought about both a diversification of building types and a redefinition of their spatial programs (Bozpınar, 2021). Production-oriented building types such as traditional houses, workshops, silkworm cocoon drying buildings and silk factories are not isolated architectural formations rather, they reveal direct spatial reflections of the transformation in economic relations. Therefore, the development of these typologies should be evaluated not only through the diversity in form, scale, and materials but also through the connection between production and social organization and market relations.

Silk production, which began in Southern Marmara using traditional methods, accelerated industrialization in the region from the 19th century onwards by integrating with the demands of the global market, changing the structure of the local workforce (especially women's employment), and transforming Bursa and its surroundings into pioneering industrial centers of Ottoman modernization. (Oral, 2004). Traditional silk production is passed down from generation

to generation as a cultural heritage. Cultural heritage is a treasure that introduces members of society to their shared past, strengthening feelings of solidarity and unity among them. It enables understanding of the experiences people have accumulated throughout history, the continuity of their shared past, and the proper planning of the future (Erkal, 1994). In other words, cultural heritage can be defined as "the totality of physically existing artifacts created by people, inherited from the past and intended to be passed on to the future for various reasons, as well as the values belonging to a society." (Çapar & Yenipınar, 2016).

The preservation and transmission of cultural heritage to future generations is possible not only through the physical maintenance of structures, but also by integrating them into contemporary social life; in this context, reuse is the process of revitalizing historical fabric by equipping it with new functions that can meet contemporary socio-economic and cultural needs without damaging its original identity and architectural values (Ahunbay, 1996). Therefore, historical structures involved in the traditional silk production process are of great importance in terms of cultural heritage.

The research problem is to address the lack of a holistic architectural reading of traditional silk production methods and traditional production structures under a single framework. In other words, the research aims to define the spatial counterparts of silk production stages by examining silk production structures holistically. The article will first describe the structures involved in the production process and their place in the production processes. Then, the architectural features of the structures and their relationships with their locations will be explained. Next, information about the production capacities of the structures will be provided.

The main objective of the research is to examine the spatial impact of silk production processes, the morphological transformation from traditional houses, workshops, and cocoon houses to silk factories, and the interaction between production and space. In addition, it aims to comprehensively examine the spatial counterparts of the technical equipment and operational processes necessary for silk production, to document the structures, to identify the technical equipment, and to explain their architectural relationships.

This study is a reference work that comprehensively defines, classifies, and spatially analyzes silk production structures. Its interdisciplinary approach to the relationship between production processes and architectural analysis makes it an important resource for both architectural history and cultural heritage. The study aims to convey the production processes of buildings, reflect their cultural heritage values, and present their architectural features.

RESEARCH METHODOLOGY

The geographical development of silk production in Türkiye has a multifaceted structure shaped by the country's natural environmental conditions, rural settlement characteristics, agricultural diversity, and regional production habits (Figure 2). The climate conditions suitable for mulberry cultivation, which are essential requirements for silkworm farming, seasonal temperature variations, humidity levels, and the topographical advantages of the production areas are the main factors determining the distribution of production throughout the country. Therefore, instead of being concentrated in a single region, silk production in Türkiye takes place with varying intensity in different geographical sub-regions, and this diverse distribution can be considered a direct reflection of the country's rich ecological structure on production (Bilgin, 2009; Öktem, 2018).

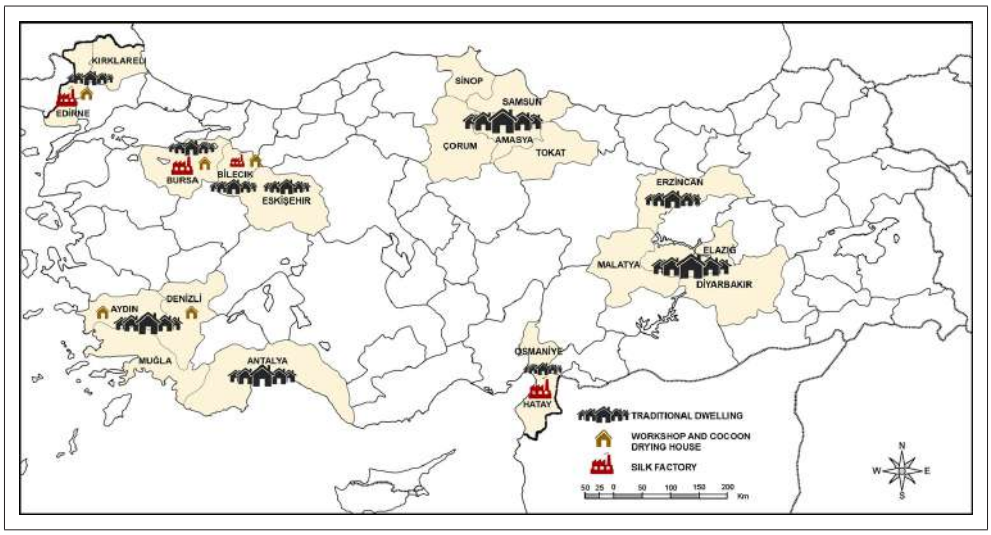

Figure 2. Map of Türkiye by showing sericulture centers (İnginar Kemaloğlu, 2023; Yıldırım, 2022) (Design by the Author, 2026).

In this study, the spatial transformation of silk production activities from traditional dwelling to factory scale is evaluated as a structural continuity encompassing all stages of production, and as a complementary whole. The importance of the research lies in describing traditional production processes through historical silk production structures and providing a detailed account of the technical equipment. This study aims to document the relationship between traditional production processes and architecture by illustrating silk production processes through architectural structures.

This research aims to conduct a comprehensive reporting study on the identified structures using observation and documentation methods (Figure 3). This includes a literature review of national and international literature, primarily focusing on industrial heritage, sericulture, and silk factories, as well as on-site visits to photograph and document the structures. Analyses were conducted on the different types of structures documented. Furthermore, the production processes of these structures have been documented, showing how the architecture was shaped by interpreting the building itself. The field research and producer interviews that constitute the methodology of the study were chosen to identify traditional production processes, which are not sufficiently documented in the literature, and to analyze the direct relationship between these processes and spatial organization. This approach allowed for the scientific recording of the technical details of the living production culture, as well as the physical texture of the structures.

In the field study conducted in the Southern Marmara Region, structures related to silk production were identified in the Bursa and Bilecik regions (Figures 4, 5, 6). Information regarding silk production and the functioning of these structures was obtained through discussions with the Bursa Eskişehir Bilecik Development Agency (BEBKA) and the Bursa Silk Cocoon Agricultural Sales Cooperatives Union (KOZABİRLİK). In addition, interviews were conducted with local people to explain the relationship between the production process and the silk production structures.

Located within Bursa's historical fabric, these factories served not only as production areas but also as vital components of the city's economic cycle during their operational period. Proximity to transportation networks, commercial markets, and labor resources was a decisive factor in the location of these factories. The settlement context now encompasses not only natural conditions but also the urban socio-economic structure. Since each of the large-scale production processes—drying, storage, sorting, spinning, weaving, and dyeing—requires a specific spatial organization, factory buildings are constructed on large plots using modular or courtyard layouts. In many of these structures, the proximity of production units ensures the continuity of the production line and provides logistical convenience. Another consequence of being in city centers is the use of innovative solutions in building materials and structural systems.

Structures related to silk production are grouped under three main headings: Traditional dwellings where silkworms were raised, silk workshops and cocoon drying buildings, and silk factories. All types of structures are involved in different processes in silk production and contribute to the overall production. The study first examines how the stages of silk production, from raw material to final product, determine the spatial organization of the structures. The structural characteristics of the buildings, such as their plan schemes, material uses, and construction techniques, are detailed. In addition to the physical boundaries of the space, the decisive role of the settlement in which the buildings are located on the architectural character is emphasized.

The research examines traditional houses, workshops, cocoon drying houses, and silk factories involved in the silk production process. A spatial analysis of the structures

Figure 3. Map of site visit in the Southern Marmara Region (Google Earth, prepared by the Author, 2026).

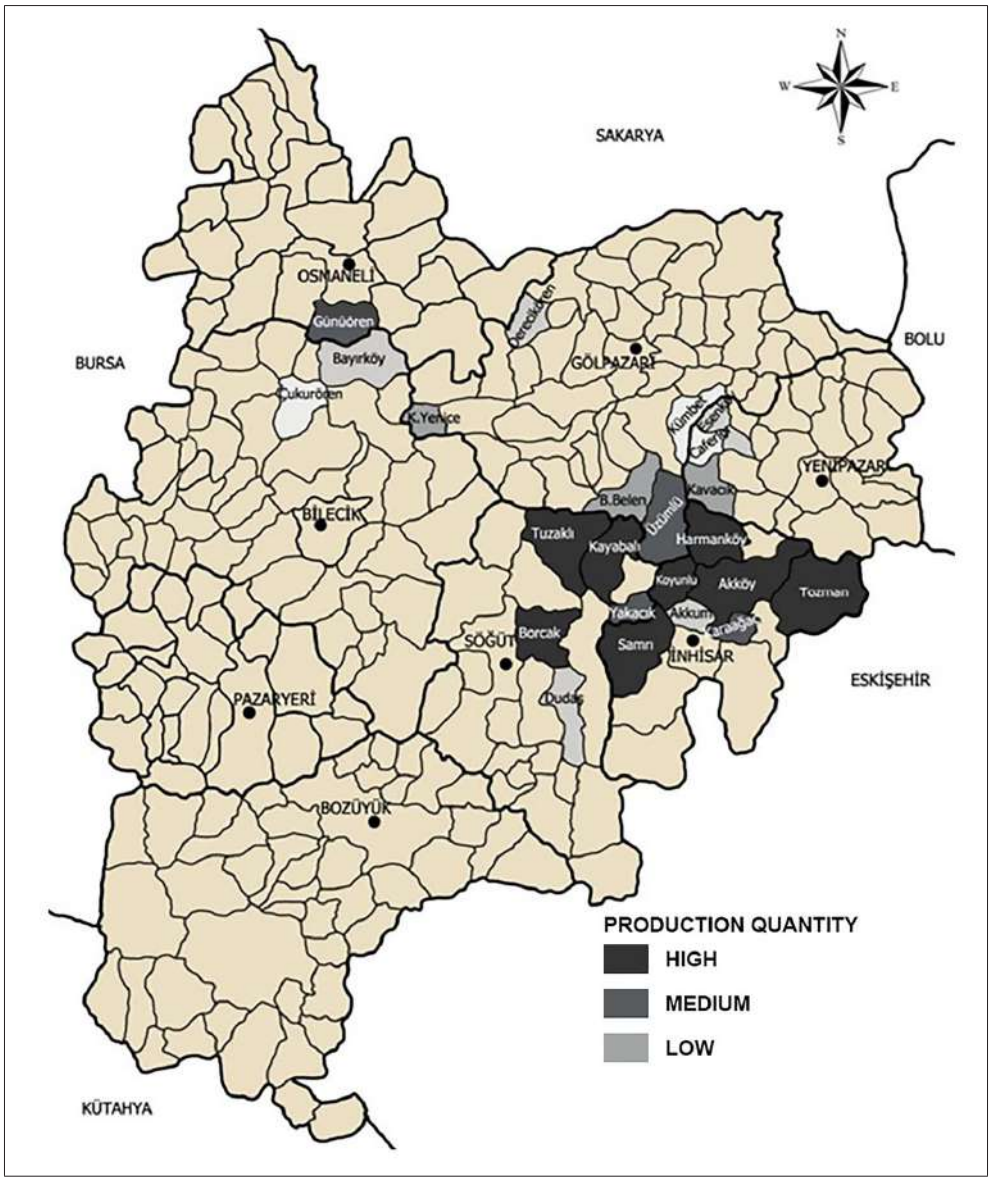

Figure 4. Settlements of traditional silkworm dwellings in Bilecik (Başkaya, 2014, prepared by the Author, 2026).

identified through fieldwork will be conducted, production processes will be interpreted through the structures themselves, and building types will be documented.

EVALUATION OF SILK PRODUCTION STRUCTURES

Definition of Buildings and Production Process

The traditional silkworm house reflects a micro-production model based on agriculture and manual labor, where family life and production are carried out under the same roof. The biological stages of production—from egg hatching to silkworm feeding and cocoon formation—are organized within the house (Çiftçi, 2013). Fieldwork conducted in Tuzaklı village, located in Söğüt, Bilecik, documented traditional houses, settlements, street views, facades, insect areas, and interior views (Figure 7).

A workshop is a small-scale facility where cocoons are transformed into raw silk yarn. It represents the transformation of local production, transitioning from residential settings into a semi-industrial intermediate form under the pressure of increasing demand and commercialization. Cocoon house is a technical building designed for drying, classifying, and storing cocoons. The cocoon drying facility acts as a functional interface to ensure the quality of the cocoons after harvest, thus ensuring continuity in the supply chain (Oral, 2004). Workshops and cocoon houses provide a continuity of production and space between traditional housing and factories. Cocoon house ensures the preser-

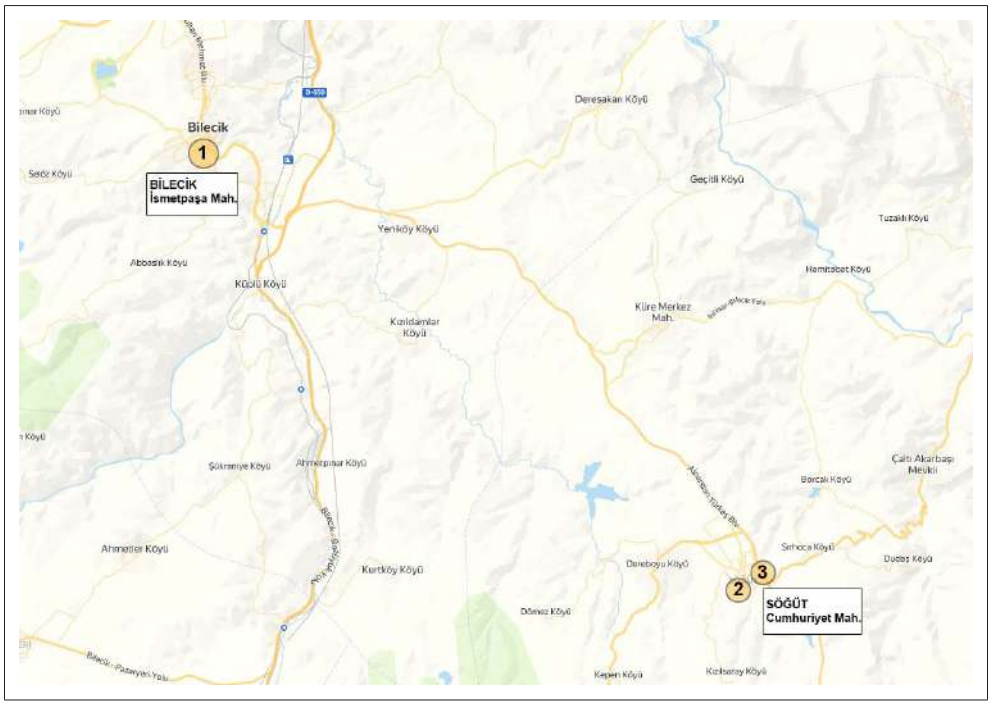

Figure 5. Settlements of silkworm cocoon houses and workshops in Bilecik (Google Maps, prepared by the Author, 2026); (1-Bilecik Silk Factory, 2-Söğüt Cocoon House-1, 3-Söğüt Cocoon House-2).

vation and standardization of the harvest, while workshops create a rational spatial separation that meets the heat, humidity, and water requirements of the physical processing stage (Oral, 2004). This dual structure is a critical step in

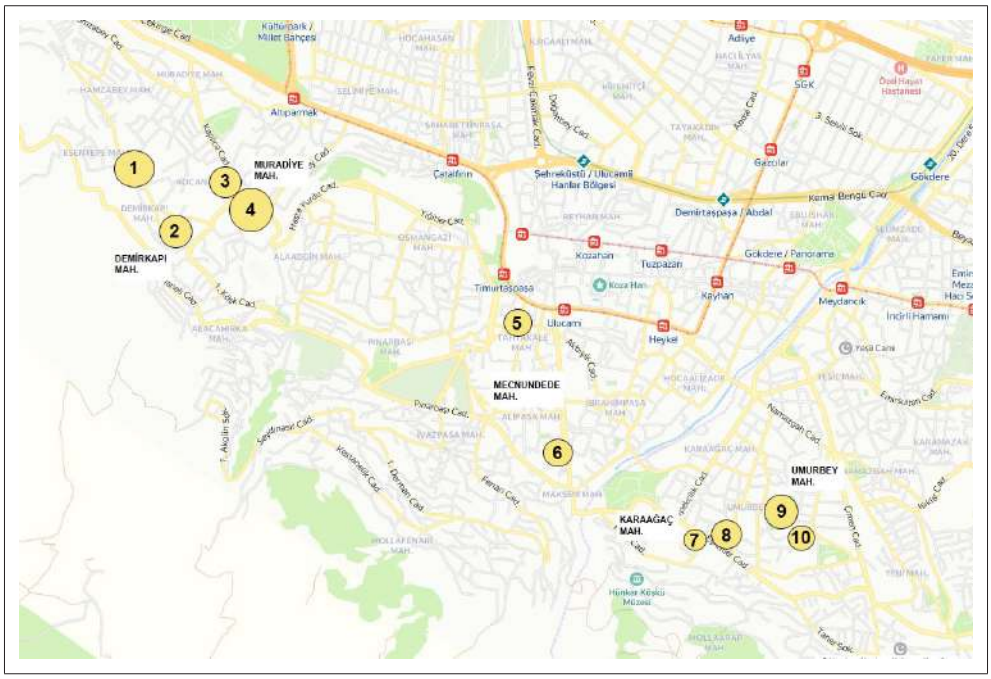

Figure 6. Settlements of silk production buildings in Bursa (Google Maps, prepared by the Author, 2026); (1-Doğan Yılmazipek silk factory, 2-Duruer silk factory, 3-Fabrika-i Hümayun, 4-Turgut Yılmazipek silk factory, 5-Resulzade dying house, 6-Rıfat Özbek silk factory, 7-Mehmet Yüksel silk factory, 8-Osman Fevzi silk factory, 9-İpeker silk factory, 10-Ete Mensucat dying house, 11- Mustafa Dörtçelik silk factory).

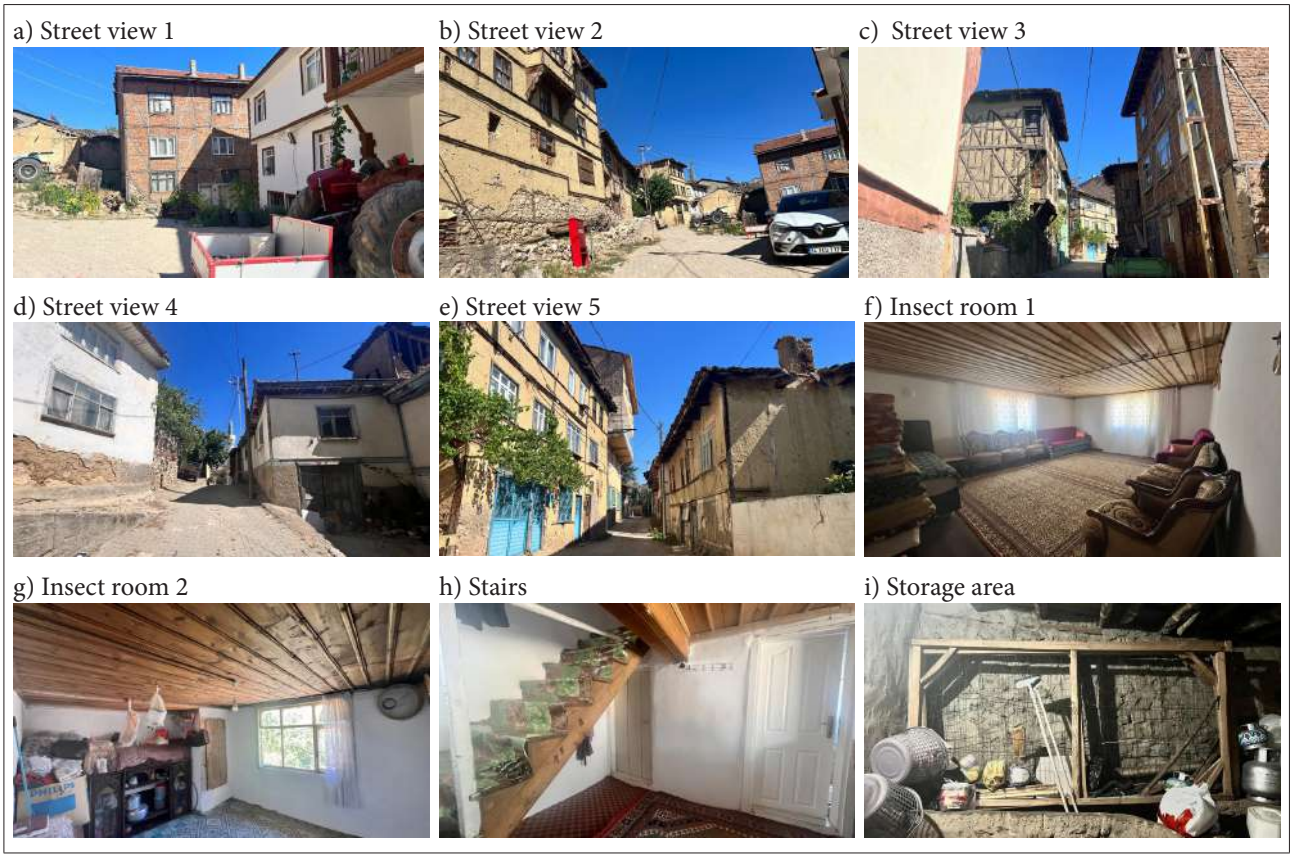

Figure 7. Traditional house in silkworm raising (These photos have been documented through field work in Söğüt, Tuzaklı village, 2024): **a)** Street view 1, **b)** Street view 2, **c)** Street view 3, **d)** Street view 4, **e)** Street view 5, **f)** Insect room 1, **g)** Insect room 2, **h)** Stairs, **i)** Storage area.

scaling up rural production and institutionalizing knowledge. Fieldwork in Söğüt, Bilecik, has documented cocoon house and workshop structures (Figures 8, 9).

Silk factories are a type of industrial building where cocoons are transformed into yarn and finished products using industrial-scale mechanical systems. The structures appearing in the Bursa and Bilecik regions from 19th century onwards embody the spatial transition from domestic and workshop-scale activities to large-scale mass production (Çiftçi, 2013). Built using the technical and typological influences of European models from Italy, France, and Switzerland, these facilities utilized steam power and later electric spinning machines, significantly increasing production efficiency and standardization. The processes of cocoon supply and storage, steam boiling, mechanical reeling, drying, and twisting followed by dyeing and weaving preparation were planned sequentially and modularly. Fieldwork conducted in Bursa has documented images of the Turgut Yılmazipek silk factory (Figure 10).

Spatial Organization and Architectural Features of Silk Production Buildings

The architectural and spatial characteristics of structures associated with the silk production process change and diversify in parallel with the nature, scale, and technological development of production. The building types examined in this study are considered as parts of a successive production chain within the historical continuity of sericulture. Since each stage of production requires different spatial conditions, sericulture structures exhibit significant spatial differentiations depending on the settlement environment. This differentiation can be most clearly observed in three basic structural models: Traditional dwellings in rural areas, workshops and silkworm cocoon drying buildings located in border regions between rural and urban areas, and finally, large-scale silk factories emerging in urban centers (Table 1).

The architectural examination of numerous traditional dwellings reveals a systematic relationship between domestic spaces and the technical requirements of silk production. It was determined that the architectural diagrams of all the structures visited showed similarities. Within the scope of this article, a sample house in Tuzaklı village is documented (Figures 11, 12, 13, 14, 15). Traditional housing examples stand out with their spatial arrangements that accommodate the early stages of production. The spatial organization in these structures integrates both residential and production functions within the same building. The use of the upper floors for silkworm

Figure 8. Silkworm cocoon house (These photos have been documented through field work in Söğüt, 2024): **a)** Street view, **b)** Windows, **c)** Cocoon house area, **d)** Interior view 1, **e)** Interior view 2, **f)** Interior view 3.

rearing and cocoon formation has been decisive in terms of the orientation of the spaces, their light intake capacity, and their heat storage capabilities. The fact that the upper floor generally opens to the warmer south and east, and the large openings that allow natural light to enter, are spatial decisions shaped by the biological needs of production. Generally, when we look at the characteristics of these houses, we see that they have tiled roofs, are suitable for silkworm breeding, are limited to one or two floors, have a limited number of rooms, and are constructed using a wood-frame and adobe infill technique. (Karşıyaka, 2019). The thermal and moisture performance of the material is critical for this production phase. The spatial transformation that the traditional house undergoes during its production periods demonstrates the high capacity for flexible use of the structure, and production directs the entire spatial organization at the scale of the house.

In Bilecik and its districts, many workshops and silkworm cocoon houses belonging to non-Muslims and Armenians were constructed. Records from 1906 indicate 11 workshops and silkworm cocoon houses in Bilecik and 4 in Söğüt (Demiryürek, 2018). Currently, only one silk factory has been identified in Bilecik, and two cocoon houses in Söğüt. This article focuses on the Söğüt silkworm cocoon house as an example (Figures 16, 17, 18, 19).

Figure 9. Workshop (These photos have been documented through field work in Söğüt, 2024): **a)** Street view 1, **b)** Street view 2, **c)** Street view 3, **d)** Interior view 1, **e)** Interior view 2.

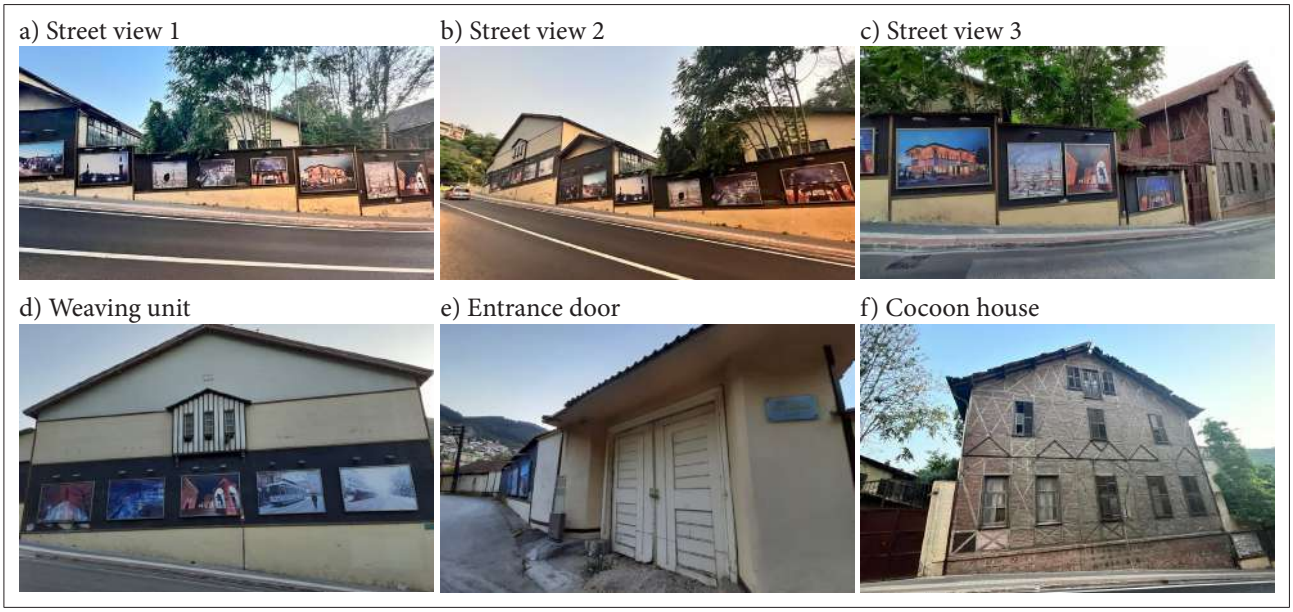

Figure 10. Silk factory (This photo has been documented through field work in Bursa, 2024, Turgut Yılmazipek silk factory): **a)** Street view 1, **b)** Street view 2, **c)** Street view 3, **d)** Weaving unit, **e)** Entrance door, **f)** Cocoon house.

Silkworm cocoon houses represent one of the most characteristic spatial solutions of silk production. The silkworm cocoon house is constructed using brick masonry. The ground floor was designed as an undivided space containing a stable and food storage area, as well as a storage area for mulberry leaves necessary for silkworm breeding. This allowed fresh mulberry leaves to be preserved without losing moisture and quickly transported to the upper floors for feeding the silkworms. The first floor, accessed by stairs from the ground floor, was the living floor; the sofa area, where the room doors opened, was located here. On the upper floors, verandas were positioned in the areas where

Table 1. Documented buildings in the Southern Marmara Region (Prepared by the Author) (The structures shown in the table were identified through fieldwork, 2026)

No	Building Name	Province	District	Current Status
1	Traditional Houses	Bilecik	Söğüt/Tuzaklı	Dwellling
2	Traditional Houses	Bilecik	Söğüt/Kayabalı	Dwellling
3	Traditional Houses	Bilecik	Söğüt/Harmankoy	Dwellling
4	Söğüt Cocoon House-1	Bilecik	Söğüt	Unused
5	Söğüt Cocoon House-2	Bilecik	Söğüt	Unused
6	Bilecik Silk Facto	Bilecik	Merkez	Unused
7	Doğan Yılmazipek Silk Factor	Bursa	Osmangazi	Unused
8	Duruder Silk Factory	Bursa	Osmangazi	Office
9	Fabrika-i Humayu	Bursa	Osmangazi	Educational Building
10	Turgut Yılmazipek Silk Factor	Bursa	Osmangazi	Unused
11	Resulzade Dyehouse	Bursa	Osmangazi	Ruined
12	Rıfat Özbek Silk Factory	Bursa	Osmangazi	Unused
13	Mehmet Yüksel Silk Factory	Bursa	Yıldırım	Unused
14	Osman Fevzi Silk Factor	Bursa	Yıldırım	Cultural Center
15	İpeker İpek Silk Factory	Bursa	Yıldırım	Museum
16	Ete Mensucat Dyehouse	Bursa	Yıldırım	Art Center
17	Mustafa Dörtçelik Silk Factor	Bursa	Yıldırım	Ruined

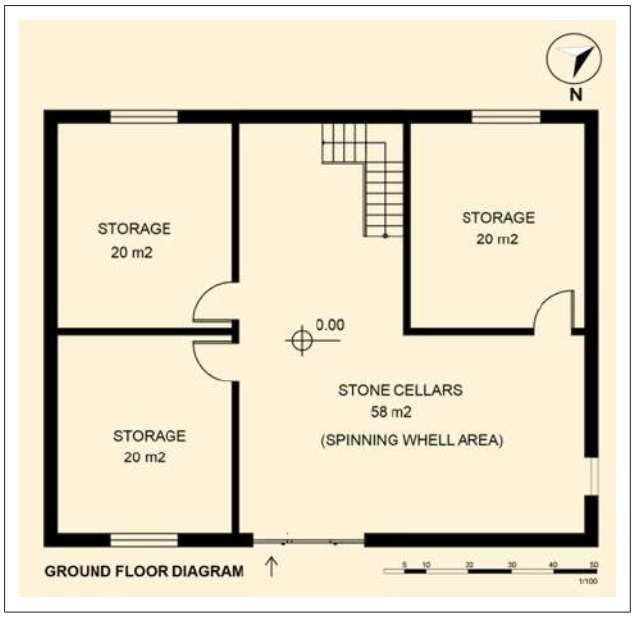

Figure 11. Traditional house plan 1 (Söğüt, Tuzaklı) (Design by the Author, 2026).

the sofa opened to the outside, and scaffolding was erected for storing mulberry leaves, enabling silkworm breeding. A special space known as the silkworm cellar was created on the top floor, giving the house plans a unique identity (Bilecik Governorship, n.d.). The upper floors were bright and spacious areas where cocoon production took place. Vertical spatial organization is a key determinant in these structures. The high air circulation required for the cocoon drying process has led to the building shell becoming a surface almost entirely defined by ventilation elements.

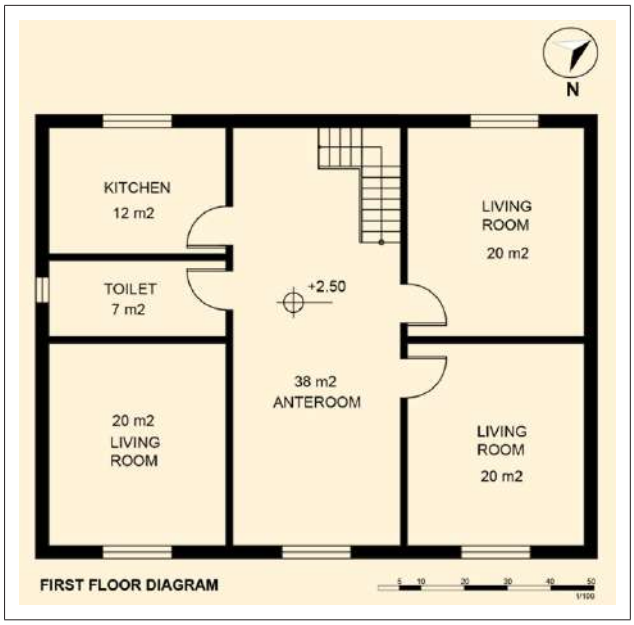

Figure 12. Traditional house plan 2 (Söğüt, Tuzaklı) (Design by the Author, 2026).

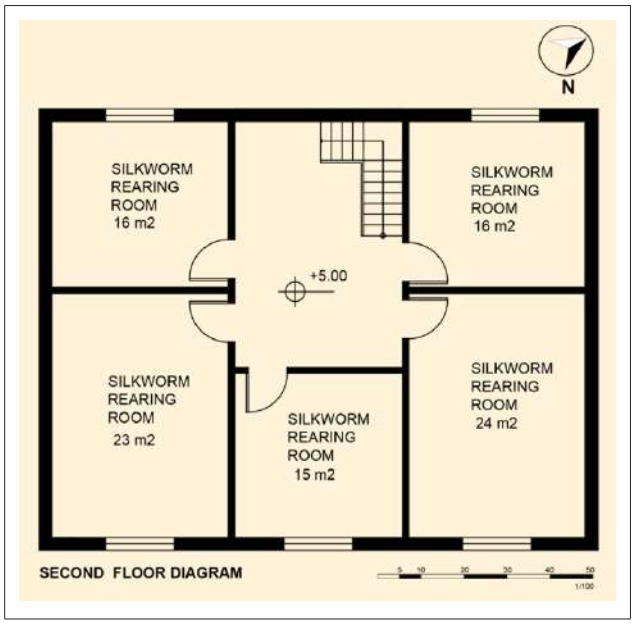

Figure 13. Traditional house plan 3 (Söğüt, Tuzaklı) (Design by the Author, 2026).

Small, frequent, and opposite openings placed at regular intervals along the floors create a continuous airflow within the space. This flow ensures that the drying process takes place simultaneously and efficiently on all floors. The lightness and permeability of the wooden floors in the interior contribute both to continuous ventilation and to the portability of the cocoon baskets. The weaving looms on the lower floors of the houses completed this production cycle, as they were the spaces where the silk obtained from the produced cocoons was directly processed. Thus, this vertical production chain, extending from the storage function on the ground floor to the cocoon drying on the top floor, completely shaped the inter-floor organization of the dwelling. The structure has been transformed from a mere shelter into a fully designed silk production facility (Bilecik Governorship, n.d.). These unique qualities are the defining characteristics that distinguish silk production architecture

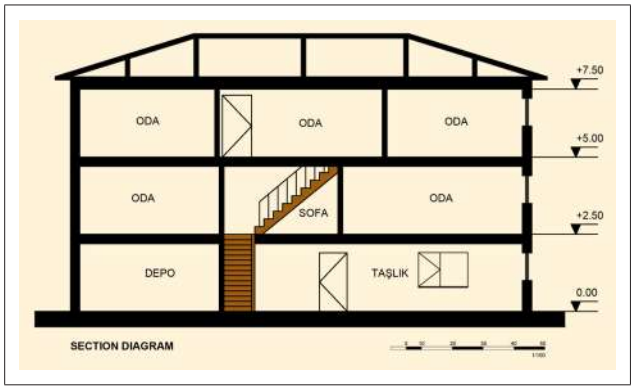

Figure 14. Traditional house section (Söğüt, Tuzaklı) (Design by the Author, 2026).

Figure 15. Traditional house facade (Söğüt, Tuzaklı) (This photo has been documented through field work in Söğüt, Tuzaklı village, 2024).

from other forms of industrial heritage.

The fact that cocoon drying chambers are mostly 3-4 stories high, with a narrow rectangular plan and a repeating mass composition, is an architectural decision that directly meets the requirements of spatial repetition and vertical cyclicality of the production process. Silkworm cocoon structures feature skylights, while the narrow, long windows on the upper floors utilize wooden shutters. These skylights and the narrow, long side windows, along with their shutters, directly control air circulation and light balance, which are critical to the silkworm's development. Maintaining constant temperature and humidity during the cocoon-spinning phase, and ensuring rapid airflow during the drying phase, are made possible through these architectural openings (Ministry of Culture and Tourism, n.d.). The workshops consist of single-story structures located adjacent to the cocoon house, where medium-scale yarn spinning and cocoon boiling operations are carried out. The workshop, located adjacent to the building, houses wet processing steps such as unwinding the cocoons and winding the yarn, thus forming an integrated production line together with the dry volume of the cocoon factory. The hearth and chimney arrangement provides the controlled heat environment necessary for suffocating the wet cocoons and performing the initial drying processes, while the large window openings in the single-story section allow this heat to escape evenly, preventing excessive moisture accumulation (Ministry of Culture and Tourism, 2024).

Figure 16. Silkworm cocoon drying building (Söğüt Cocoon House-2) (This photo has been documented by author through field work in Söğüt,2024).

Figure 17. Silkworm cocoon house facade (Söğüt Cocoon House-2) (This photo has been documented by author through field work in Söğüt, 2024).

Silk factories evolved into more complex structures as silk production reached an industrial scale, with the production line directly reflecting the space. The silk filigree factories in Bursa were industrialized from the mid-19th century onwards by being equipped with steam technology, and this transformation radically changed the scale and organization of the production spaces (Quataert, 1987). The spatial organization of the factories was designed to follow a linear production flow; the cocoon receiving area, drying units, boiling section, spinning halls, twisting, and weaving areas, and large-volume warehouses were built in a sequential order (Figures 20, 21, 22, 23, 24, 25). The factory complex incorporates a combination of different construction systems. The factory features timber frame systems, stone masonry, and stone systems, as well as reinforced concrete and steel systems used in later constructions (Erder, 1978). The structural system, utilizing iron columns and beams and early reinforced concrete techniques, allowed for the creation of large, open spaces (Kıvılcım Çorakbaş et al, 2026). High-ceilinged production halls provided a spatial environment compatible with the working principles of the machines, while tall chimneys and a steam room

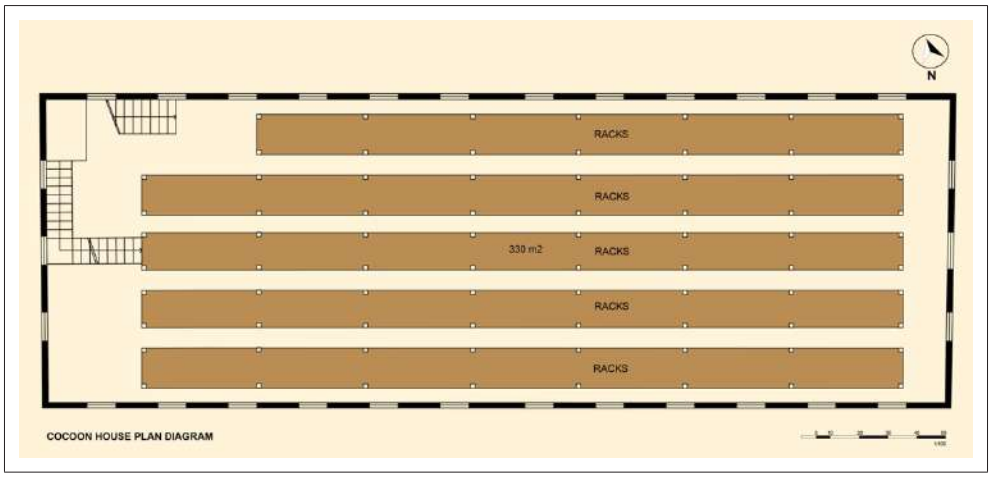

Figure 18. Silkworm cocoon house plan (Söğüt Cocoon House-2) (Design by the Author, 2026).

played a significant role in controlling the circulation of heat and steam within the space. The process of extracting silk threads from cocoons involves boiling hot water and the disposal of the resulting waste, which is a crucial step. Therefore, a large amount of fast-flowing water is required (Çiftçi, 2017). For this reason, silk factories are generally located near flowing water.

As a general comparison, traditional houses offer a small-scale production type suitable for the initial stages of production and sensitive to environmental conditions, while rural cocoon houses form functionally specialized linear types suitable for the drying and storage stages of production. Silkworm cocoon house within factories, on the other hand, emerge as large-scale industrial types that develop with spatial standardization, modular repetition, and mass production logic as production volumes increase. This transition directly reflects the transformation of sericulture from a traditional agricultural activity to an industrial form of production. This situation reveals a continuous structural synthesis in the architectural evolution of sericulture structures in the Southern Marmara Region, reflecting the transition from traditional family farming to heavy industrialization. This developmental trajectory demonstrates a clear morphological shift parallel to the growth of production volumes and technological advancements. Initially, traditional dwellings housed the entire biological cycle under a common roof, relying on the highly flexible and adaptable use of residential space. As commercial demands intensified, production broke away from the arrangements within the dwelling, leading to the emergence of specialized cocoon houses and workshops. This semi-industrial transition institutionalized regional know-how through distinctive architectural expressions such as upper-floor insect traps and window shutter systems designed solely to control ventilation and microclimatic parameters. Ultimately, with the integration of steam power in the late 19th century, this evolutionary trajectory culminated in the birth of large-scale silk factories. In these industrial spaces, the former organic integration of life and labor was completely replaced by a highly standardized, modular, and linear production flow. When this seamless architectural evolution

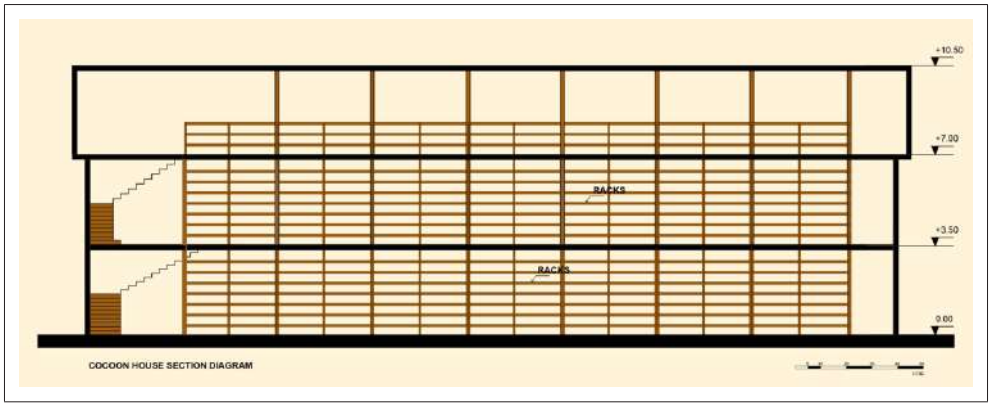

Figure 19. Silkworm cocoon house section (Söğüt Cocoon House-2) (Design by the Author, 2026).

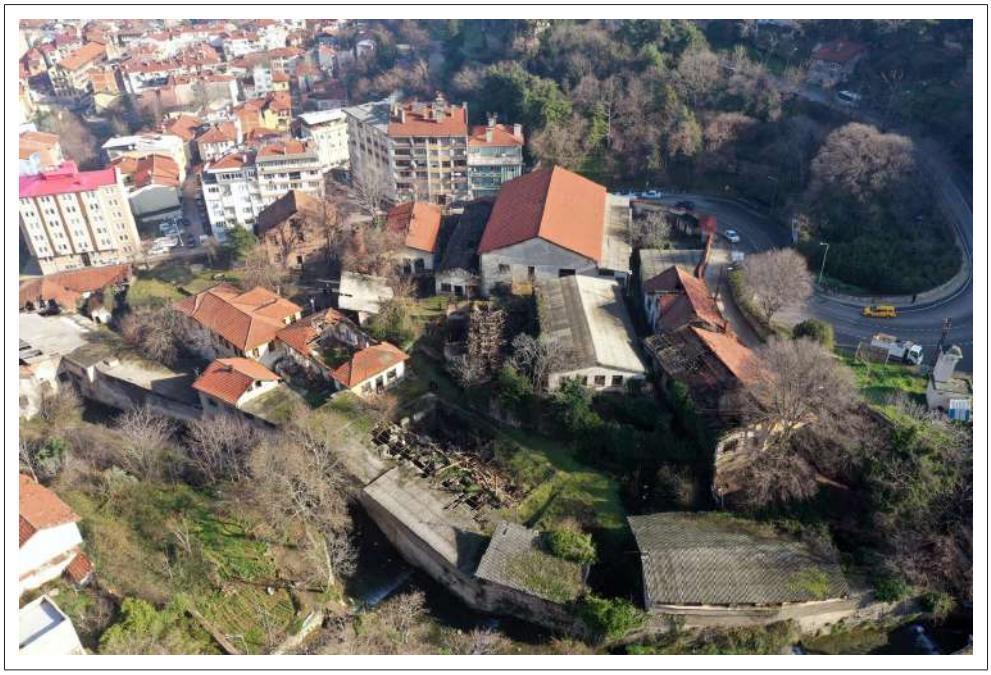

Figure 20. Turgut Yılmazipek silk factory (Bursa) (Osmangazi Municipality, 2025).

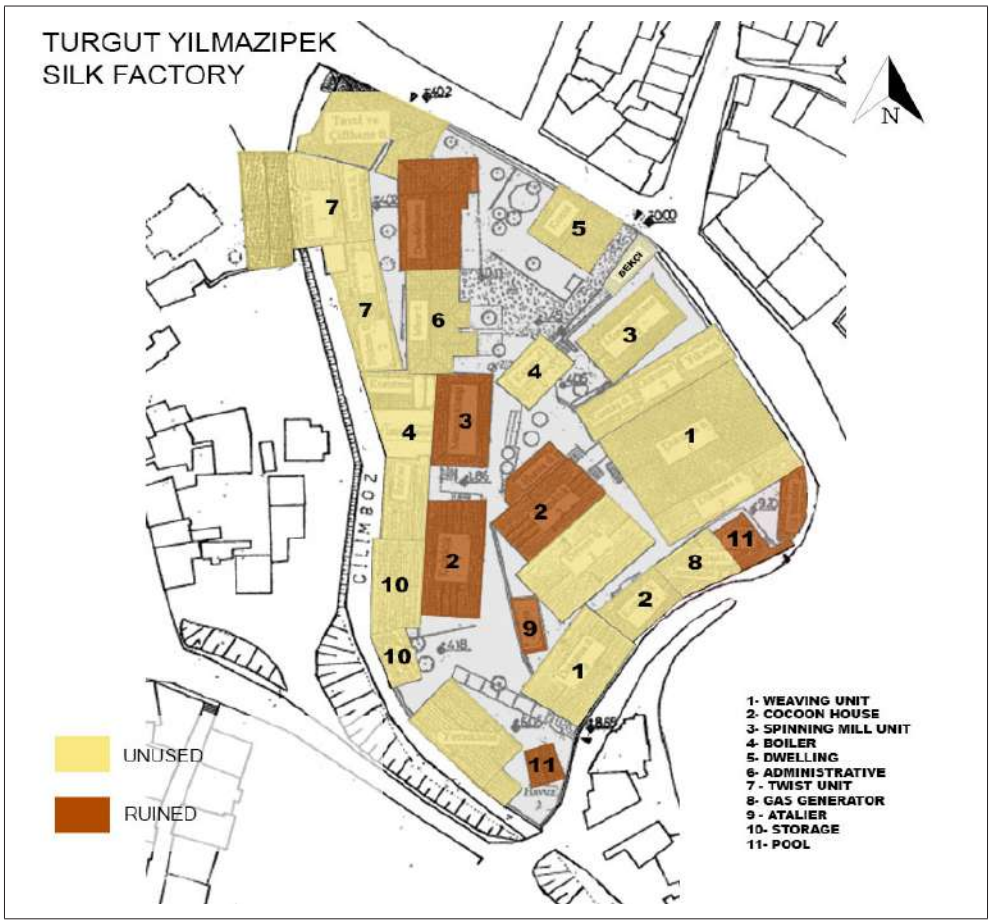

Figure 21. Silk factory site plan (Turgut Yılmazipek Silk Facotry, Bursa) (Adapted by the Author based on the site plan taken from Oral, 2004).

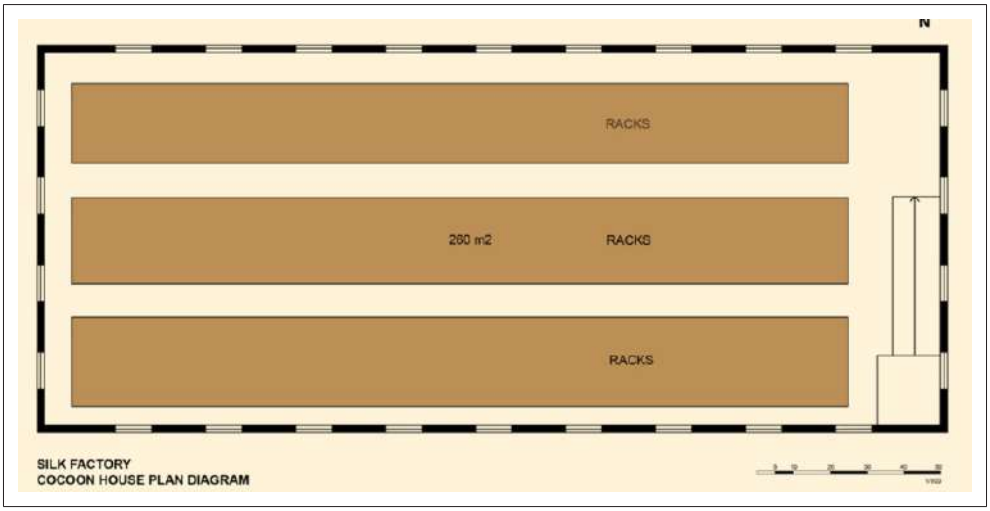

Figure 22. Cocoon house plan (Turgut Yılmazipek Silk Factory, Bursa) (Prepared by the Author using plan drawings produced by Oral, 2004).

from rural housing to urban factories is traced, it becomes clear that each technical stage of silk production generated a precise and enduring spatial counterpart, making sericulture a defining catalyst for regional industrial heritage.

Production Capacity of Buildings

One of the most important factors influencing the architecture of sericulture facilities is production capacity. Although the silk production process consists of many stages, from egg to larva, from cocoon formation to spinning, and from spinning to weaving, the basic equipment that directly determines this process is: Silkworm rearing looms, cocoon drying racks, traditional and industrial spinning mill, and weaving machine (Figure 26). Therefore, the main elements that determine the production scale and spatial dimensions of the structures are the number, size, and arrangement equipment.

Field research, technical visits, and archival research have revealed that in traditional production periods, small-scale residential production typically involved a single area for insect rearing, cocoon spinning, and drying on the upper floors of houses. A small workshop containing spinning equipment was usually located either below or adjacent to this area. Silkworms that have turned into cocoons are sent to the nearest cocooning facility or factory. In earlier times, before the establishment of workshops and factories, silk spinning was done using hand-operated slingshots located in homes. These types of small-scale production units had limited production capacity and were usually run by a single family. The production cycle begins with biological processes such as the hatching of larvae (caterpillars) and cocoon spinning; these activities are carried out in special rooms within the dwelling called "silkworm feeding room". The process continues by boiling the cocoons in water and

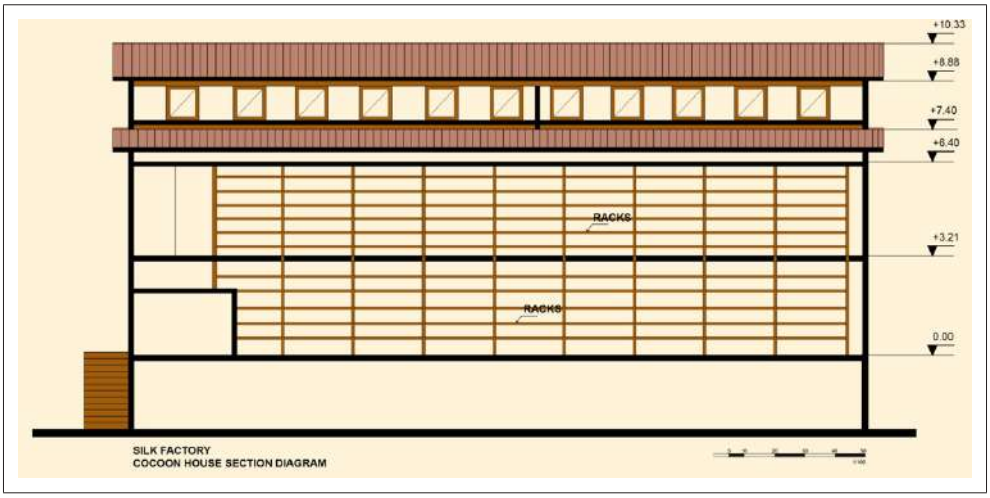

Figure 23. Cocoon house section (Turgut Yılmazipek Silk Factory, Bursa) (Prepared by the Author using plan drawings produced by Oral, 2004).

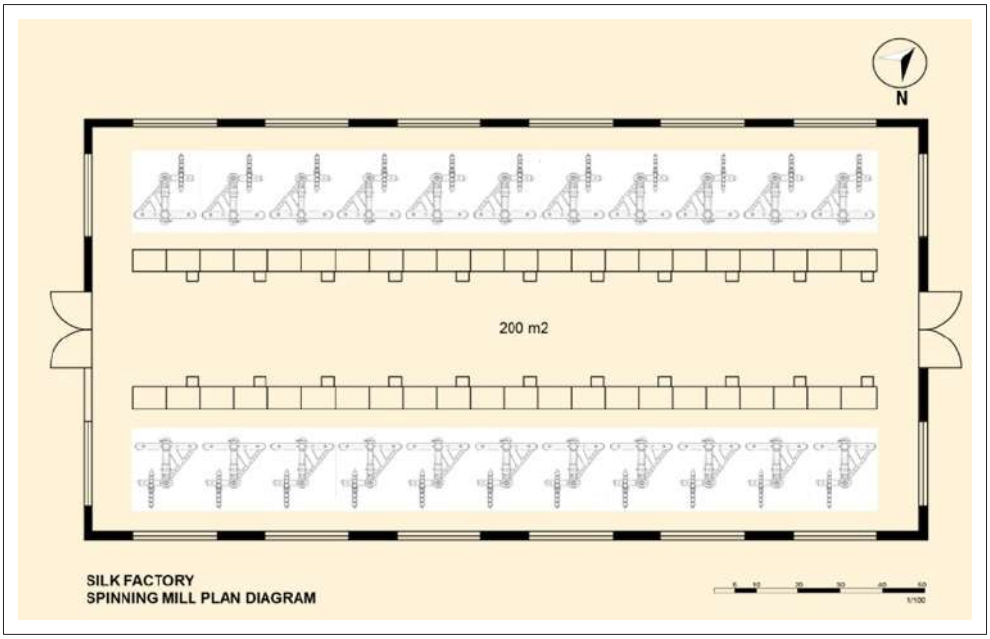

Figure 24. Spinning mill building plan (Turgut Yılmazipek Silk Factory, Bursa) (Prepared by the Author using plan drawings produced by Oral, 2004).

spinning the thread with a spinning wheel for silk thread. This stage, requiring wet areas and technical equipment, is carried out in service areas of the dwelling known as "stone cellars" or "storage areas" (Figure 20).

In workshops and silkworm cocoon drying buildings, production has become semi-industrial, separate from residential settings. These structures feature a drying rack system with numerous drying racks, equipment for spinning multiple yarns, and traditional weaving looms, thus increasing production capacity (Figure 20). Medium-sized production areas typically have 3-4 story silkworm cocoon drying buildings with attics. Cocoons are thinly arranged on these racks and dried for 3 months. Since a moisture-free environment is necessary for the drying process, wood with moisture-absorbing properties is preferred in the construction of these cocooning facilities. All windows have wooden shutters to prevent sunlight. In a medium-sized building, the volume of a single cocoon storage floor is approximately 900 m^3. 18-20 m^3 of volume is required for one ton of wet cocoons. Assuming a 15% volume loss for circulation, air gaps, and structural elements, this volume

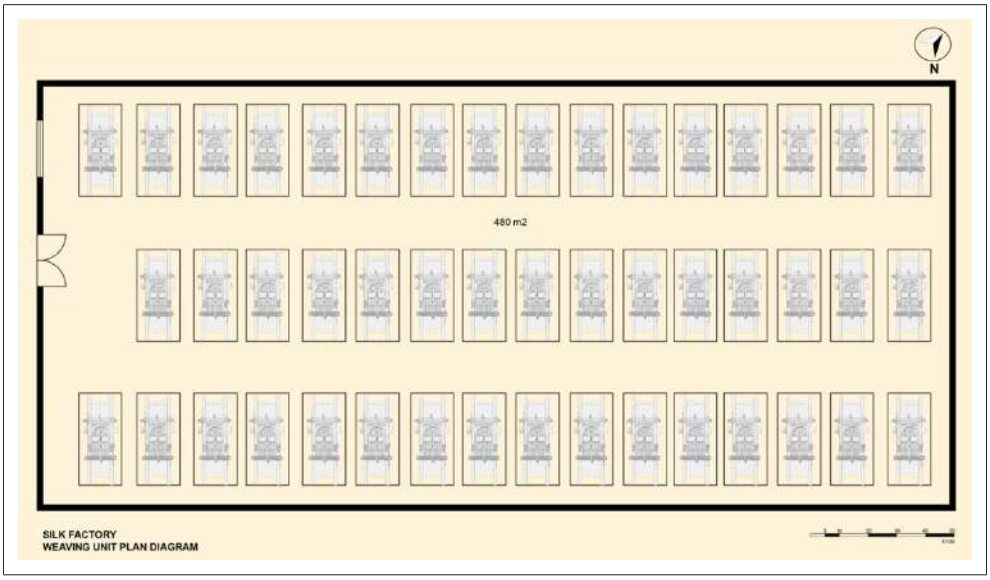

Figure 25. Weaving unit plan (Turgut Yılmazipek Silk Factory, Bursa) (Prepared by the Author using plan drawings produced by Oral, 2004).

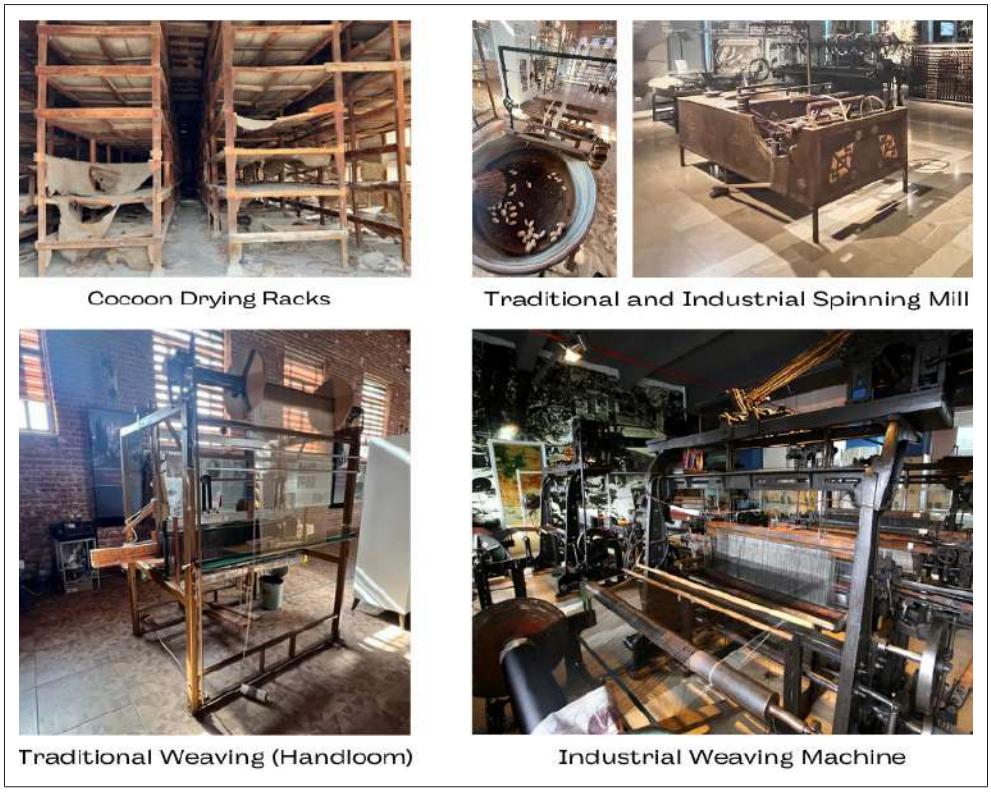

Figure 26. Traditional and industrial equipment (Prepared by the Author) (These photos have been documented through field work, 2024).

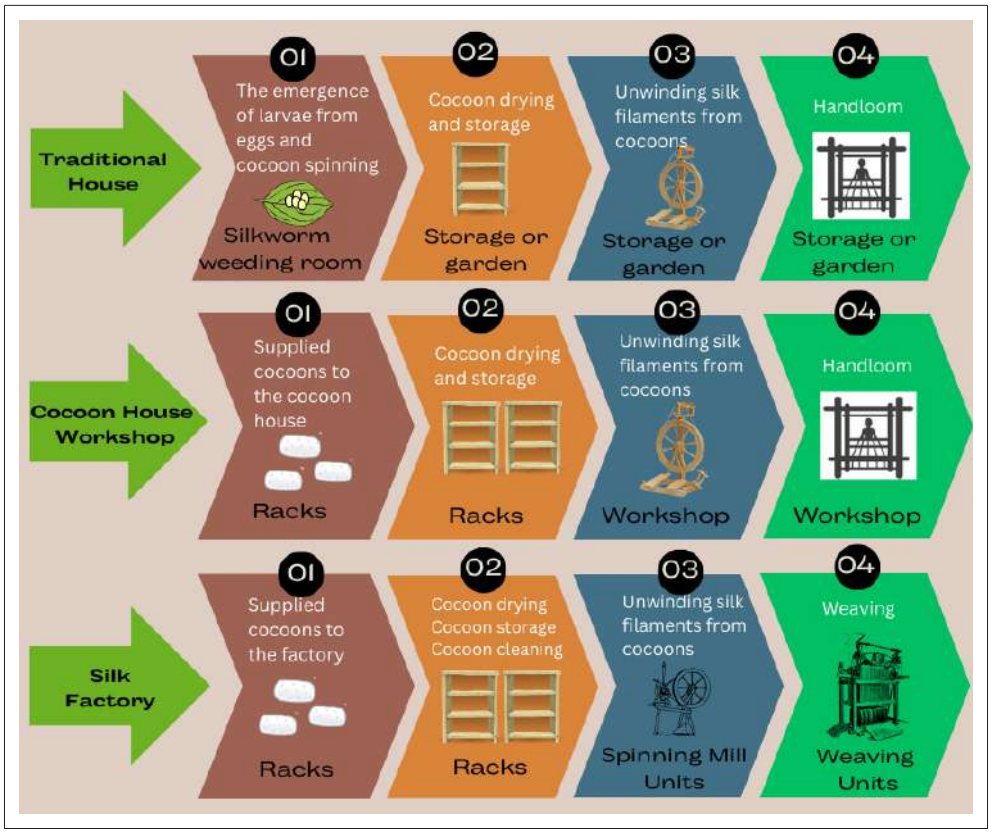

Figure 27. Diagram of silk production stages in buildings (Prepared by the Author based on fieldwork, 2026).

provides approximately 38-43 tons of wet cocoon storage capacity (Ministry of Agriculture and Forestry, 2023). Since the weight of cocoons decreases by 1/3 when dried, this results in approximately 26-30 tons of dry cocoon capacity. Therefore, cocoon storage capacity is directly dependent on the volume of the space. Being typically three-story, with the ground floor used for storage, there is approximately 1800 m^3 of drying space available. In total, a single building has 76-86 tons of wet cocoon storage space. The workshop structure located next to the cocooning area contains 4-6 spinning machines for the yarn spinning process. These structures, of this scale, have become regional centers where cocoons collected from surrounding villages are processed. The process of transforming the raw material into yarn using a "spinning machine" requires mechanical equipment, thus necessitating a special workshop area called the "Workshop".

Large-scale silk factories are designed to encompass the entire process, from raw material input to the final product: Fabric. These structures include cocoon drying and storage facilities, steam spinning machines, weaving and production sections; mechanical flow and division of labor are ensured between production units. In large-scale factories built after the 1920s, silkworm cocoon drying buildings are separate from the main production facilities and featured interior wooden racks for the drying process. They generally consist of 2-3 floors, with an average area of 300-380 m2 and a volume of 900-1100 m3 per floor. In this case, they have the same wet cocoon drying volume as medium-sized structures. That is, an average of 76-86 tons of wet cocoon storage space is available in a single building. While cocoon production capacities are similar in large-scale and medium-scale production structures, there are differences in the production process. Medium-scale structures provide seasonal and short-term storage, while large-scale structures are used continuously throughout the year. In medium-sized buildings, they are located independently or near residences or workshops, while in large-scale buildings, they are directly connected to the factory production line. The most fundamental difference is that factory-scale structures contain multiple silkworm cocoon drying buildings; in addition to having the same production capacity as medium-scale facilities, the number of these structures has been increased (Figure 27). In large-scale facilities, cocoons dried in the silkworm cocoon drying buildings are successively sent to the cocoon drying unit, spinning mill units, twist mill and warp mill. The equipment within these units determines the production capacity of the facilities. In large-scale facilities, silk is spun in spinning mill units. Spinning machine operating with steam power and a mechanical system provide better standards in the spun yarns compared to those using hand spinners. The production chain begins with preparatory processes such as drying, sorting, and storing the cocoons; these processes are carried out in "Silkworm Cocoon Drying Buildings". The process continues with the "Spinning Machine Unit" for silk reeling, the "Warping/Twisting Unit" for yarn processing (warping/twisting), and the "Weaving Units" for the final textile product (Oral, 2004).

For the sake of methodological transparency, the numerical estimates and volumetric capacity calculations presented in this section were obtained through a triple analysis of comprehensive fieldwork, archival records, and official technical data. The physical dimensions and spatial volumes of the documented cocoon houses were determined through direct on-site measurements and architectural documentation during the field research. To convert this volumetric spatial data into accurate production capacities, data from the Ministry of Agriculture and Forestry's (2023) official technical report containing standard spatial parameters for cocoon storage areas were integrated.

According to field observations and archival records, the silk production process began on a residential scale, and later, as production volume increased, silkworm cocoon drying buildings and workshop structures emerged. In the subsequent period, silk factories were established to meet the growing demand and needs. The biological process continued at a residential scale. Workshops and silkworm cocoon drying buildings served as a bridge between residential and factory settings. Factories enabled the industrialization of silk production (Table 2).

CONCLUSION

This study reveals the morphological and spatial transformation in the traditional sericulture and silk production heritage of the Southern Marmara Region through a holistic architectural reading, ranging from rural housing scale

Table 2. Building scale-production capacity relationship (Prepared by the Author based on archival records, fieldwork and technical reports, 2026)

Type of Structure	Number of Cocoon Houses	Capacity of Cocoon Strage	Type of Steam Boiler	Number of Spinning Machine	Number of Weaving Loom
Traditional Houses	Unavailable	50-60 M2	Small Hot Boiler	1	Unavailable
Workshop and Silkworm Cocoon Drying Buildings	1	900 M2	Small Scale Steam Boiler	3-4	1
Silk Factories	2-3	1800-2700 M2	Big Scale Steam Boiler	8-12	8-10

to industrial factory scale in urban centers. The original findings of the research demonstrate that all biological and technical stages of silk production processes are directly reflected in architecture as spatial counterparts, shaping building forms. In the traditional houses of Tuzaklı village in Söğüt, micro-scale production intertwined with family life has been transferred to cocoon drying houses and workshops in Söğüt as production has evolved into a semi-industrial intermediate form through commercialization. In this context, the frequent ventilation openings, wooden shutters, and functional floor organizations that ensure continuous air circulation in the cocoon houses are the most concrete evidence of how production directly designs the architectural shell and spatial typology. From the 19th century onwards, large-scale silk factories in Bursa, which emerged with the integration of steam technology, represent the highest scale of production, where the linear production flow completely standardized the architecture, consisting of modular and high-ceilinged halls. The case studies documented and analyzed in this study are now cramped within the urban fabric and face the threat of becoming derelict. Preserving these structures as tangible cultural heritage for the future is possible not only through the preservation of their physical integrity but also through their integration into the contemporary socio-economic ecosystem. In this regard, adaptive reuse models should be developed that do not harm the architectural identities and spatial dimensions of the original structures examined. These models include living silk museums, art studios, creative industry centers, or the transformation of factory courtyards into public squares, thus keeping the region's traditional production culture alive. In conclusion, this research fills a significant gap in the literature by clearly defining the spatial counterparts of silk production processes and the evolutionary trajectory of architectural spatial analysis. The data and methodological documentation obtained provide a scientific basis and reference source for future conservation, restoration, and repurposing interventions for sericulture heritage in the Southern Marmara Region.

ETHICS: This study did not require approval from an institutional ethics committee because it involved no clinical procedures, personal data collection, or intervention with human participants.

PEER-REVIEW: Externally peer-reviewed.

CONFLICT OF INTEREST: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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