




# Construction Tools Used by Ottoman Architects and Engineers in the Classical Period

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**Abstract.** Construction activities in a state are concrete data that provide information about the political, social, economic situation and science and technology of the state. These activities of states are not independent of the dynamics in question. Building activities in the Ottoman Empire, a great empire, were shaped according to these dynamics. The political history of the Ottoman Empire is generally divided into two: the classical and the Westernization period. However, when the construction activities in the Ottoman Empire were examined, it was seen that this distinction would also be valid for construction practices. In particular, the change in the perception of science and technology has caused the tools and materials used in construction to change. In this study, construction tools were examined in the light of written sources from the classical period. Classical period construction techniques, tools and materials were examined in the light of three Works. The two works are named Tezkiretü'l Bünyan and Tezkiretü'l Ebniye, which describe the life and works of Mimar Sinan. Another work is called Risale-i Mi'mariyye, which gives information about Mehmed Ađa's works. The tools used were identified in the light of the works in question.

**Keywords:** Mimar Sinan · Tezkiretü'l Bünyan · Tezkiretü'l Ebniye · Construction material · Construction tools

## 1 Introduction

The relationship between science, technology and engineering and the succession between these concepts vary throughout the historical process. In order to say something about the relationship between the concepts in question, historical records need to be examined and exemplified. There are many examples showing that science and technology have developed along different routes throughout history. The tools designed in the early periods show that the development adventure of science and technology was not the same and simultaneous. The fact that the tools of ancient times contained empirical knowledge and lacked scientific knowledge caused the products to be called technical rather than technological. The tools that incorporate scientific knowledge have brought technology to us. This situation brought about machines. Recent times have been the period when science and technology were seen as inseparable concepts and studies in these fields were reflected in engineering studies. Studies on science, technology and

engineering constitute an important part of the change and transformation in a society. The concepts in question have a structure that is affected by the political, social and economic dynamics of the states. For this reason, science, technology and engineering studies in a society's civilization and modernization adventure have a structure that both affects and is affected by the society.

While investigating the modernization line of the Ottoman Empire, its attitude towards science and technology should not be ignored. Because this attitude is not independent of the political structure, economic situation and educational approach of the Ottoman Empire. Considering these dynamics, it would be correct to say that the distinction between the classical and Westernization periods made for the political history of the Ottoman Empire is also valid for the perception of science and technology. Because the different political, social structure and economic situation of the two periods were also reflected in the Ottoman perception of science and technology. The best example of this situation is the Tanzimat period. The Tanzimat period has an important place among the steps taken in the Westernization initiatives of the Ottoman Empire. The Tanzimat period, which made it possible to experience many innovations in the political, legal and educational fields, also affected the construction activities of the Ottoman Empire. New building types, new techniques, and the transition from wooden to masonry construction were seen in the Tanzimat Period. For this reason, the Tanzimat period should be considered the beginning of the modernization process in terms of construction activities. The change movement in construction practices was supported by the Tanzimat intellectuals and bureaucrats who opened up to Europe and expressed the need to include construction activities in the change movement. Mustafa Reşid Pasha's suggestions regarding the necessity of changing construction practices in the Ottoman Empire had a great impact. While he was the London ambassador, he was disturbed by the derogatory statements about Muslims in European newspapers due to the fires that broke out in the Ottoman Empire, and he insisted that the Ottoman Empire follow Europe in construction activities [1]. Thanks to this insistent attitude of Reşid Pasha, new city plans were made, the materials used were changed, and architects and engineers were employed. The changing perception of science and technology as a result of these Westernization initiatives was reflected in educational institutions, construction knowledge and written literature. New construction techniques, materials and tools can be accessed by examining the works taught in engineering schools.

Construction activities were influenced by the spirit of the period, both in the Westernization period and in the classical period. The political structure, economic situation, socio-cultural structure and perception of science and technology of the period shaped the construction activities of the classical period. When the construction techniques and works of the classical period of the Ottoman Empire are mentioned, the first name that comes to our mind is Mimar Sinan. A study based on Mimar Sinan provides extensive information about the construction techniques of the period. Mimar Sinan's works and the techniques he used can be accessed through the works named Tezkiret'ül Bünyan and Tezkiret'ül Ebniye. Another work that provides information about the period is Risale-i Mimariyye. In this study, the works in question were examined and the tools used in the construction activities of the period were identified.

## 2 Classical Period Construction Techniques, Materials and Tools

If we want to explain the Ottoman Empire, which spread over a wide geography in the 16th century, in the context of an architect and a building, these names would undoubtedly be Mimar Sinan and Süleymaniye. It has been defined as the classical period of Ottoman building activities as a result of the productivity and original attitude of Mimar Sinan (1490–1588), who served as the chief architect at Hassa Mimarlar Ocağı between 1539–1588<sup>1</sup>. There are two problems related to Mimar Sinan. The first is the issue of his identity. The second problem is about determining its place in the history of science and technology. The second problem concerns the subject of our study. The reason why this situation has become a problem is due to the lack of written literature on the history of architecture. Examination of Sinan's extant works by architects and engineers will reveal the scientific and technological dimension of his works. In this respect, Sinan's place in the history of science and technology has emerged not through the written sources of the period, but as a result of current studies on his extant works. With his unique style, he left permanent traces in the lands where the empire spread, and became the most well-known architect of the pre-modern - classical period - Islamic World. Although information about him has survived to the present day in the form of five different autobiographies, the most well-known works are Tezkiret'ül Bünyan and Tezkiret'ül Ebniye, of which we have a list of buildings [4]. The work called Tezkiret'ül Bünyan was written as a conversation between Mimar Sinan and his friend Sai Çelebi. Through this study, we can reach Mimar Sinan's buildings and his relationship with the sultans.

The work named Tezkiret'ül Ebniye consists of thirteen chapters and in this work Sinan's structures are given as a list. Through this work, we can access Mimar Sinan's building list and how productive he was.

Chapter 1: Names of mosques

Chapter 2: Masjid names and numbers

Chapter 3: Names and numbers of madrasahs

Chapter 4: Names and numbers of places where the Quran is taught

Chapter 5: Number of soup kitchens

Chapter 6: Numbers of hospitals

Chapter 7: Names and numbers of waterways

Chapter 8: Names and numbers of bridges

Chapter 9: Names of palaces

Chapter 10: Names of caravanserais

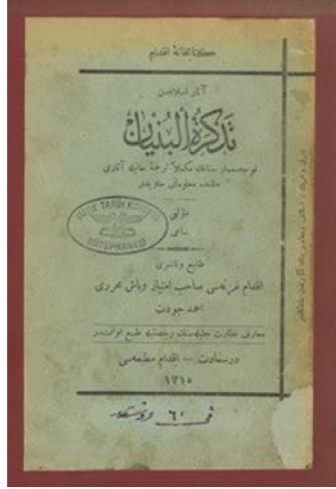
Chapter 11: Names of Cellars

Chapter 12: Names of baths

Chapter 13: Provides the names and numbers of the tombs

We can access the materials, tools and technical information used through Tezkiret'ül Bünyan. The mentioned books enable us to access the names and functions of the tools used in the construction practices of the period. Mimar Sinan frequently mentions the use

<sup>1</sup> For detailed information about Hassa Mimar Ocağı, please see:- Erdenen, O., Osmanlı Devri Mimarları, Yardımcıları ve Teşkilâtları, "Mimarlık", 4, (1) 1966, 15–18.- Orhonlu, Cengiz, Şehir Mimarları, "Osmanlı Araştırmaları", 2(2),1981, 1–30.



**Fig. 1.** Tezkiret'ül Bünyan

of large cranes and pumps in construction activities. Sinan refers to the tool used to drive piles both in the construction of the Süleymaniye Mosque and the Büyükçekmece Bridge as a hammer. This tool, known as a hammer, is used as “Şahmerdan” in the text. [4]. Additionally, while explaining the bridge construction in Büyükçekmece, he informs that pumps were used to discharge the water. Materials such as wood, brick, tiles, nails, lead and tin are used in buildings. Another material used in Ottoman constructions is marble. The marble used in buildings is supplied from other regions. Mimar Sinan also mentions in his work that the marbles to be used in the construction of the Süleymaniye mosque were brought in different ways. While designing the plan of Süleymaniye, Architect Sinan considered supplying the stones, marbles and columns he would use from ruined buildings in different regions of the Ottoman Empire. He supplied four columns to be used in the construction of Süleymaniye: two columns from Alexandria, one column from Ba'albek, and one column from Kıztaşı District in Istanbul [4] (Fig. 1).

Another work is called Risale-i Mimariyye, written by Cafer Efendi, which provides information about Mehmet Ağa, the architect of the Sultan Ahmed Mosque [3]. A second biographical work in the history of Ottoman architecture is Risale-i Mi'mariyye. In this work written by Cafer Efendi, the life story and works of Mehmed Agha, the architect of the Sultan Ahmed Mosque, are told. This work, which is a biographical work, should also be considered as the architectural dictionary of the period. Building types, architectural measurement units, material and tool information are given in Turkish-Persian and Arabic equivalents (Fig. 2).

The thirteenth and fourteenth chapters of this work, which consists of fifteen chapters, contain information about the vehicles.

The tool names we encounter in the work called Risale-i Mimariyye are as follows:

There is information about the tool called “mi'vel” in Arabic and kulünk in Persian and Turkish, a pickaxe with two sharp edges used to break stones.



Fig. 2. Risale-i Mi'mariyye Cafer Efendi 1023/1614 (Contents and introduction of the work)

The tool known as “sâkur” in Arabic and “mîtn” in Persian is the tool that means big “külünk” in Turkish, meaning big pickaxe.

The tool known as “mustara” in Arabic is called “cendere” in Persian and Turkish.

The tool known as “atele” in Arabic means “sekne-i büzürg” in Persian and “iy” in Turkish. This tool, known as atele in Arabic, is an iron pickaxe used in construction. Other tool names mentioned in the text are mallet, big hammer, pliers, polishing tool, pickaxe, and hoe. The tools mentioned are the tools used in classical period construction activities. For example, The tool known as “saykal” or “sakl” in Arabic means polishing in Turkish. Masters carrying out Ottoman construction activities used this tool to smooth newly laid concrete.

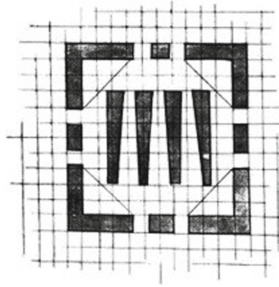
With this study, we learn about construction materials as well as tools. The material known as “helik” in Turkish and meaning “milât” or “melât” in Arabic is the clay placed inside the wall. This material, known as leukun, called saruç in Arabic, is the material we know as plaster today.

When both the works named *Risale-i Mimariye* and *Tezkiretil Bünyan* were examined, it was seen that; These works provide information about the technique, material knowledge and tools of the period.

In the light of the works in question, the method used in classical period Ottoman construction technology is as follows:

The construction activities mentioned in both works show that the construction in the classical period was in three stages. The first stage; It consists of decisions taken and bureaucratic permissions before starting construction. In the second stage, plans and projects are drawn and materials and labor are provided. In the third stage, letters indicating that the construction has been completed are being prepared. Studies on Ottoman building technology have generally been carried out on single structures. The researcher conducting the study chose an example to explain Ottoman building technology and aimed to reveal Ottoman building technology through this example. Studies of this type; It allows us to witness the construction stages of Ottoman construction. When these works are examined, the stages of Ottoman construction activities are generally as follows: The preliminary phase of Ottoman construction; Providing the basic materials for a construction constitutes preparations for providing the workforce. Then, measurements called “*mesaha*” in Ottoman architectural terminology are carried out on the area where the construction will be carried out.

After measurements of the construction area are made, a project is prepared for the construction area. The fact that the plans and projects of the classical period buildings have not survived to the present day prevents us from having information about the project planning system of the period. The plan and project designed at the beginning of construction are expressed by the “*karname*” in the Ottoman Empire [1]. “*Karname*”, which comes from the word “*Karnümâ*”, is the sample plan presented by apprentices to become masters [5]. There was a modular system used in plan drawing in Ottoman constructions. The paper on which the project will be drawn is squared with horizontal and vertical evenly spaced lines. These lines, determined with a tool called “*Mistar*”, are applied on paper. “*Mistar*”; It is a tool used to make the necessary lines to show the lines correctly [5].



The next stage for the buildings whose plans were drawn, or more accurately, whose charters were prepared, in the Ottoman Empire was the supply of materials and labor. The fact that the Ottoman Empire did not have technical tools, large cranes, machines, and road networks in the present sense made the supply of materials and workers difficult and costly.

In Ottoman constructions, after the material supply, the construction first begins with the construction of the foundation. In order to improve the area on which a building will be placed, the foundation is first built. The fact that all sides of the ground structure are not equal makes it necessary to make all sides of the ground equal. The method used in this case is pile foundation construction. If the designed structure is a bridge, the foundation construction is done in a different way. During bridge construction, water should be prevented from entering the construction area and it should be kept dry throughout construction. This temporary process acts as a dam and is called a cofferdam [8]. Sinan attributes the reason for the dilapidation and collapse of the bridge built in Büyükçekme before Sinan to the fact that the bridge was built on a swamp and was built on wet ground [4].

Columns and arches, which are the individual elements of the load-bearing system, solved many problems in Ottoman classical buildings. The construction of the columns on the ground, among the reused building elements, was achieved in a different way in Ottoman architecture than in the ancient period. This system, called “connection collar”, is used to connect the column and the floor together [8].

Following the load-bearing systems, the covering system of the building is included in the construction. The elements of this system are domes and vaults. Wood and iron are used in the construction of covering systems. Although the use of iron was not as common as it was after the Industrial Revolution, it was seen in classical period buildings starting from the 16th century [8].

The process described above regarding the Ottoman construction technique has shown that the Ottoman construction process has had a system since the classical period. The process, which started with determining the location of the construction site, continued with the preparation of the report book and then the procurement of labor and materials. Following the completion of the preparation phase for construction, the construction process started with the foundation and continued with the construction of carrier and cover systems.

### 3 Conclusions

The classical period was a period when the Ottoman Empire had large lands. The construction activities initiated by the Ottoman Empire in the large areas it spread over and in the cities, it dominated continued at a rapid pace. Many attempts have been made for the development and construction of cities. The existence of an institution was needed to realize these initiatives. For this reason, “Hassa Mimarlar Ocağı” was established towards the end of the 15th century. This institution played a major role in shaping the zoning and construction activities of the Ottoman Empire. All construction activities were carried out with the permission of this institution.

In this study, the tools and materials used in the classical period were researched in the context of Mimar Sinan and Mehmed Ağa, who worked at Hassa Mimarlar Ocağı. The works providing information about the mentioned architects constitute the written sources of the construction technology of the period. When we look at the classical period Ottoman construction and architectural practices, the sensitivity shown by the Ottomans in building activities was not reflected in the historiography of these areas.

For this reason, the sources called *Risale-i Mi' mariyye* and *Tezkiretü'l Bünyan* are important works that enable us to make inferences about the construction technology of the period. We learn about Mimar Sinan's method, the materials and tools he used in his buildings, through *Tezkiretü'l Bünyan*. We can access information about the architecture of Mehmed Ađa, the architect of Sultan Ahmed Mosque, through *Risale-i Mi' mimariyye*.

In this study, the works of the two architects mentioned were examined and information about the tools used in the construction technology of the period was obtained. It has been determined that the Ottoman Empire had a certain technique in construction activities in the classical period and was sensitive in terms of the tools and materials with which it carried out this technique.

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