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Analytical Study of the Architecture of Historical Bathhouses in Isfahan Province from the Perspective of Physical Geometry

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ABSTRACT

Since ancient times, Iranians have cared about cleanliness and respected water to the point of sanctity. In Islam, purity before prayers became doubly important, and consequently, the bathroom emerged as a space for washing, which was accompanied by physical changes over time. Today, historical bathhouses are facing the risk of destruction, without detailed studies on their architecture. This research aims to identify the physical characteristics of historical baths in Isfahan province. This study tries to answer the question of what are the architectural features of historical baths in Isfahan province from the perspective of physical geometry. With a descriptive-analytical method, the study focuses on three main axes (typology, spaces, and proportions). Data has been collected through field studies and research findings have been analyzed using statistical methods. The results show that all the studied bathrooms included the main, connection, and service spaces. In Isfahan, as Safavid capital, the baths in the neighborhood were bigger than the city center baths. The differences between the total area and the area of Bineh and Garmkhaneh show that the size of the baths depended on the population of the bath area, so the urban location (city center or neighborhood center), physical type of the bath, and other factors did not affect it. Due to various usages, Bineh was much larger than the Garmkhaneh. But unexpectedly, the large Binehs were relatively low in height. The closeness of the proportions of the Bineh and Garmkhaneh shows the harmony of the shape of the said spaces.

Keywords: *Architecture, Bathhouse, Isfahan Province, Physical Geometry.*

1. Introduction

Cleanliness of the body has been of special importance to the Aryan people since ancient times. There are many documents about the sanctity of water and the necessity of cleanliness among Sabians [1], Mithraists [2], and Iranian Zoroastrians in the pre-Islamic eras [3]. As Islam started spreading in Iran, cleanliness and purity became a double necessity, and obligatory ghusl and multiple daily washings (ablution) became especially important from a ritual point of view. On the other hand, the recommendations of the religious authorities to maintain cleanliness, and its essential role in the health of the individual and the society, made bathing and washing one of the common methods of health and treatment.

Although for the act of washing according to Islamic rules, it is not necessary to have a building of a bath, the

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act of body washing has been typically performed in a place called hammam or garmabeh. It is architecture [4]. However, throughout history, the knowledge, skill, and capacity of Iranian artists gradually transformed it from a metal container called Abzan (washbasin) into a space that shows itself like a cut jewel in the heart of an irregular texture. The existing knowledge of this historical process is mostly based on written documents and archeological findings, which mainly show the formation of the architecture of the baths based on needs [5].

Due to various reasons, bathhouses are considered one of the most vulnerable types of architecture, which have always been subject to major changes or complete destruction. On the other hand, some of the baths of the Timurid era are located outside Iran and there is no information about their condition. Obviously, with such little and chaotic information, it is not possible to provide an accurate picture of the bathhouses of that era based on physical and functional analyses, and one has to rely on the texts left over from those times. The Safavids, taking power in 907 A.H. and almost after the Timurids, could establish the central government. Following the Shia intellectual principles, overcoming the rivals and local rulers, and fighting with powerful neighbors sometimes or tolerating them at other times, they could create a government that brought stability, security, and prosperity to the Iranian society, for over two hundred years.

In light of this security and good economic situation and due to many other factors, architecture flourished and artists and architects gained respect and value. Technology developed and architecture, based on previous experiences, acquired principles and standards that changed it from natural architecture to rational architecture. Accordingly, during this period, the architecture of the baths also found unique characteristics and had minor and major differences from the previous baths regarding shape and function. Based on the same principles and standards, the construction of bathhouses continued in the same way in the following eras until the beginning of the first Pahlavi rule, when the construction of bathhouses in the traditional form was prohibited and obsolete, and the body of the existing bathhouses underwent many changes to install showers.

obvious that at the beginning of its formation, the bath lacked recognizable

Therefore, the main problem of the current research is the architectural reading of historical baths from the perspective of physical geometry, and for ease of implementation, the research is limited to the baths of the Safavid era to the end of the Qajar era in Isfahan province. From the point of view of the necessity of raising the problem, the efforts made to identify and introduce Iran's bathhouses are very few, and this shows the necessity of research in this regard. In addition, the existential importance and necessity of the bath and its place in urban and rural communities, the role of the bath in the system of social relations, its strong and long-lasting connection with religious and local rites of passage and customs, remarkable relationship with medical sciences and practices, and being present in most cultural arenas are among the features that put bathhouses in a privileged position compared to other types of architecture.

On the other hand, the change in social conditions in the past few decades has caused the gradual abandonment of most public bathhouses, providing the ground for their destruction. Therefore, considering that fruitful history and this abnormal situation, there should be no doubt about the need to recognize the physical characteristics of baths as part of the cultural heritage of the Iranian world.

It was already said that Isfahan was the capital of the Safavid period and most of the masterpieces of Isfahan style were built in this city and province. Since no independent study has been done on the architecture of the bathhouses in this region, this research is focused on the architecture of the bathrooms.

This study seeks to find an answer to the question of what are the architectural characteristics of historical bathhouses in Isfahan province from the perspective of physical geometry. To find the answer, the study is focused on three main axes including physical typology, spaces and microspaces, and physical dimensions and proportions of the bathhouses of Isfahan province, and in this way, while providing a comprehensive picture of the samples; it studies the dressing room and the bathing hall as two main spaces.

1. Literature Review

1.1. Theoretical Foundations

1.1.1. The Literal Meaning of Hammam: The equivalent of bath in Persian is hamma ,an Arabic word. Some people distinguish between the terms *Hammam* and *Garmabeh* as the first referring to the public bathhouses with khazineh (a cistern of hot water which was used for ghusl and washing), and the second being used for the public baths with private rooms with showers (which are still more or less in use). It seems that this way of categorizing and naming which has been done in recent years does not have a strong scientific and lexical basis because according to what is seen in ancient texts and also what comes from authentic cultures, the two words hammam and garambah are synonymous with each other.

From a specialized point of view, in architectural books and sources, Mohammad Karim Pirinia has explained the word garmabeh as a combination of two words, garm and abeh. Here, abeh does not mean water, in other words, garmabeh is not equal to hot water. Rather, it refers to the place of the building, as in sardabeh (cold building), gurabeh (meaning cemetery or tomb) ..." [6].

Hashem Razi also believes that "... and the suffix -abeh, or -aveh, which appears in the words garmabeh, Sardabeh, and so on, means a roofed place with a crescent-shaped and arched roof, which is how the mihrabs were built, and the roof of the bathrooms and the cellar or the basements were built like this. The word Abbaye in French and Abbey in English means monastery and temple... [2].

2.1.1. History: The construction of the bath has been attributed to the Greek physician Hippocrates [7]. In Persian texts, it is attributed to Jamshid [8],[9]. It seems that the history and the exact way of building and inventing the bath remains in an aura of ambiguity and has taken on more of a mythical flavor. While in the historical era, much is known about the cleansing and washing ceremony, unfortunately, there is little information on the bathroom and bathing in the Achaemenid era [10], the Parthian era [11] and the Sasanian era [6].

The bathrooms of the Umayyad Palaces (Qasr Umrah & Kharbah al-Mafjar) were among the first Islamic bathrooms, which were built under the influence of Hellenic and Byzantine models [12] and Sasanian art [13]. During the Abbasid Caliphate when the existing cities became larger and new cities were developed, bathhouses gradually found their place as one of the important urban components and established their role as one of the shaping elements of the neighborhood or urban center [12]. Some authors mentioned the bathhouses of Basra [14] [15], and Baghdad [16] as good ones.

Among the baths of the Samani era, we can mention the bathhouses found in the Nishabur excavations [17]. Remains of another bathroom from the Samani era were found in the city of Jurjan [18]. There is not much material in historical books about Iran's baths during the Buyid dynasty. It seems that the bath found in Siraf (Taheri Port) belongs to the 3rd and 4th centuries of Hijri, that is, the Buyid era [19]. The old bath in Kangavar, belonging to the fourth century of Hijri, is one of the few baths that was destroyed apparently during the excavations of the Anahita temple [20]. Open-air baths from the Islamic era of Bishapur, Fars, also belong to the 4th and 5th centuries of Hijri. So far, three bathhouses have been identified and reported in different parts of Bishapur city [21].

Although the beginning of the arrival of the Mongols in Iran was accompanied by killing and destruction, gradually due to the tact, cooperation, and efficiency of the Iranian ministers, the repair of the damages and the construction of new baths began, especially since Hulagu Khan soon found a Muslim bath an interesting and suitable place [22] and probably this caused him to order the construction of Khan Bathhouse in Maragheh [6]. Based on the archaeological excavations conducted in the historical city of Harirah on Kish Island, it seems that the bath of this city also belongs to the Ilkhani era [23].

Most of the remaining baths from the Timurid era are not in the current territory of Iran. "In the excavations around Balkh, cases of the 15th century A.D. baths were found, which clearly represent the baths in that era" [24]. Another bath of this era is located in Shahr-e Sabz in Afghanistan [25]. Uba Bath is another Timurid bathhouse in today's Afghanistan, which we do not know if it exists now. Some bathhouses of the Sheibanian era, which came to power after the fall of the Timurids, have also remained in Uzbekistan [26]. In the present land of Iran, it seems that the original building of Afushte Bath in Natanz [27], Mir Emad Bath in Kashan [28] and Pahneh Bath in Semnan [29] is left from the Timurid era.

The brilliant peak of bath architecture should be sought in the Safavid era. In this era, baths were built in large numbers, and on a large urban scale,

even the small neighborhoods of the city had at least one bathhouse. In addition, they built large public bathhouses on the outskirts of the cities, next to the entrance gates, public centers of the cities, along the main market, and next to the schools and mosques. As for the number of baths, Chardin points out that when he was in Isfahan, there were 162 mosques, 48 schools, 1802 caravanserais, 273 baths, and 12 cemeteries [30]. Basic developments in the pattern of bathhouses, including the idea of building double bathhouses (twin bathhouses) were formed in the Safavid era. Also, it should be mentioned that, during this period, constructing a bathhouse became common as a public benefit and good deed [31].

The stable and institutional developments and changes of this era made the process of changing the baths from the Safavid era onwards very slow. Thus, the architecture of the baths did not change much in the Zand and Qajar eras. The prevalence of private bathrooms in homes is one of the historical characteristics of bathrooms in the Qajar era. With the increase of private bathrooms in homes, public bathrooms gradually lost their customers. During the Pahlavi era and in the first years of Reza Shah's rule, according to the order of the Ministry of Health of that time, the bathhouses were required to close the khazine and install showers. Some people attribute the construction of the first shower baths in Iran to Momtahen al-Dowlah [4] while others believe that "Colonel Simeno is the person who brought the shower bath to Iran for the first time, as Simeno shower bath located in Takhti Street (now called Ekbatan) was famous some times ago" [32]. In this way, the history of traditional baths in terms of physical and social functions ended in the Pahlavi era.

3.1.1. Bathhouse Spaces: Iranian bathhouse spaces are divided into four categories, and since this article deals with the two main spaces of dressing room and bathing hall, the other items are mentioned only briefly.

A. Main Spaces: The main spaces of the bathroom are the spaces where washing and bathing are done, including the dressing room, bathing hall, khazineh, and chal-howz [33].

- Dressing Room: The dressing room, called *Bineh* or sarbineh in Persian, was the main and largest bathroom space and often had a quadrangular or octagonal plan. The main use of the dressing room was changing dress for bathing, but resting after bathing, drinking tea, smoking hookah, and meeting and chatting with friends were also considered to be other common functions of the space [34]. Usually, in the dressing room, a special space was reserved for the elders and respectable people of the society, which was known as shahneshin (literally king seat) or private space.

- **Bathing Hall:** The bathing hall, called *Garmkhaneh* (warm room) in Persian, was the main space for washing and bathing and often had a square or octagonal plan. It included a public space for washing, rubbing the body with a special washcloth, soaping, and body massage, and one or more private spaces.

B. Connection Spaces: The entrance space is the place to change the direction of movement to enter the building, as well as the place to stop and wait in front of the building. Connection spaces are also built to create access between different spaces [33]. Entrance, vestibule, corridor, and mid-door have been listed as connection spaces [6].

C. Service Spaces: Generally, there are spaces where direct or indirect services are offered to customers. Corridor [6], Toilets, private rooms for pubic hair removal, bathroom roofs, and snow removal areas [33] are among the service spaces.

D. Facility Spaces: are spaces that are built to supply, draw, store, heat, distribute water, and dispose of wastewater. Furnaces, fuel storages, wells and tanks, and sewers are among these [33].

4.1.1. Typology of Baths: Baths can be classified into many types according to different factors.

- Based on the type of establishment, baths are classified into two categories; fixed baths (with specific architecture), and mobile baths (without architecture).
- Based on location, baths are divided into two categories; urban baths (within the city area) and rural baths (non-urban areas).
- Based on climatic situation, baths can be classified into baths of hot and dry climate, baths of cold and mountainous climate, baths of hot and humid climate baths, and baths of moderate and humid climate, each type following the principles of their local and climatic architecture [35].
- Based on users, baths can be divided into two categories; public baths, called bathhouses, which include bathhouses in city centers and main markets, bathhouses in neighborhood centers, religious minority bathhouses, quarantine baths, village public baths, roadside baths and spa baths. And the second category is non-public or private bathrooms including bathrooms in palaces and government buildings, bathrooms in the homes of

city nobles, and bathrooms in common people's homes.

- Based on shape and body, there are three types of architectural shape and body of bathrooms from the point of view of function. Single bathhouses were the most common, which can be found in many cities and villages. These bathhouses were used by men at certain hours of the day and night and by women at other hours, except the bathhouses inside the bazaars, which were only for men. The construction of twin baths became common during the Safavid era due to religious needs and requirements. Twin bathrooms include two independent bathrooms, the larger one was usually for men, and the smaller one was for women. Both bathrooms had a common facilities system and only their main spaces were separate. There is only one triple bathhouse left, called Latif or Charfasl (four seasons), in Arak. This building includes three independent bathhouses, one for men, another one for women, and the third for non-Muslim minorities.

Baths are divided into four types from the point of view of the shape of the dressing room and the bathing hall. These two parts are the main spaces of a bathhouse, which had the largest area and were the place of main activities of the bathing people. It is also necessary to explain that in this research, the types of octagons were not distinguished as separate factors, but all of them are included in the category of octagons, as seen in Table 1 [33].

Table 1. Morphological typology of dressing room and bathing hall of baths (Tabassi, 2012: 76).

Type	Dressing Room Plan	Bathing Hall Plan	Conventional Sign	Example
Type I	quadrangular	quadrangular	4-4	Large Rahnan Bath
Type II	octagonal	octagonal	8-8	Large Shah Ali Bath
Type III	quadrangular	octagonal	4-8	Khosrow Agha Bath
Type IV	octagonal	quadrangular	8-4	Large Aliqoli Bath

2.1. Isfahan Province

Isfahan province is located in the central region of Iran and its center is Isfahan. It is the sixth largest province, the third most populous province of Iran, and ranks first in urbanization in the country. This province, with an area of about 106,786 square kilometers, is located between 30 degrees 43 minutes to 34 degrees 27 minutes north of the equator and 49 degrees 36 minutes to 55 degrees 31 minutes east of the Greenwich meridian. This province from the north is limited to the Markazi, Qom, and Semnan Provinces; from the south to Fars and Kohgiluyeh and Boyer Ahmad Provinces; from the east to Yazd and South Khorasan Provinces; and from the west to Lorestan and Chaharmahal and Bakhtiari Provinces.

According to the latest national divisions, the province includes 17 counties, 60 cities, 37 districts, and 116 villages. Nayin with an area of 25123 square kilometers is the largest and Khomeinishahr with an area of 181 square kilometers is the smallest county of the province. In the hierarchical system of the cities of the province, after Isfahan metropolis (the capital of the province), the cities of Kashan, Golpaygan, Najafabad, and Khomeinishahr are on the second level, and the cities of Shahreza, Mobarakeh, Shahinshahr, and Zarinshahr are on the third level, and the other counties of the province fall on the fourth and fifth levels.

The population of Isfahan province was about two million people in 1976, which grew to five million people in 2016. Examining the population statistics of the province shows that the rate of urbanization in Isfahan province (as in the whole country) has grown significantly. (Figure 1).

3.1. Review of Previous Studies

Since washing and bathing have appeared as an all-encompassing phenomenon in all aspects of Iranian social life (from birth to death), researchers in various fields from public health to anthropology have paid attention to this architectural phenomenon. However, the number of articles on historical baths is very small compared to other architectural topics, and most of these few articles, especially in recent years, have mainly focused on

topics other than architecture. Among them, Zolfaghari discussed the customs and traditions of the bathhouse in Damghan [36], and Firouzi et al. discussed the history of Iranian bathhouses in the Iranian world from the beginning to the end of the Sasanian era [37].

Most of the few articles that dealt with the architecture of the bathhouses focused on the decorations of the baths, including Sadeghi et al. in a study entitled "Research on the motifs related to the architecture of the Qajar government and public baths in Sanandaj" have fully addressed this issue [38]. Ghasemi et al. analyzed the architectural decorations of Safavid and Qajar baths in an article [39]. In a study from a historical perspective, Sarvari Mehrabad and Amanzadeh investigated and analyzed the distribution of historical bathhouses in Tabriz, called Dar al-Saltaneh on an old map [40].

Figure 1. Isfahan Province (http://fa.wikipedia.org).

However, among the few books that have been published in recent years regarding the architecture of baths, we should mention "Historical study and formal analysis of Mashhad's Bathhouses", which, along with the historical review, deals with the architectural analysis of Mashhad's baths by Tabassi and Mousavi. At the end of the book, considering the rapid process of closure, abandonment, and destruction of public baths, a list of public baths in Mashhad (both baths with khazineh and baths with showers) is provided, which is very valuable for recording in history [41].

Among the first articles that tried to provide a physical analysis of the baths, we should mention the article on identifying the physical characteristics of Iran's bathhouses during the Safavid era, in which ten Iranian bathhouses were analyzed based on the most important physical indicators. The results of the research showed that Iran's bathhouses in the Safavid era enjoyed a kind of harmony in observing physical proportions, something which did not necessarily depend on the climatic and geographical location of the bath, the urban location, and the physical type of the bath, and other factors. Also, in that era, the dressing room of the bathhouses was wider than the bathing hall, and correspondingly, they had higher ceilings [35].

Zarei et al. studied the physical body of fourteen bathhouses in two different climate regions of Fars province. The results of the study showed that the main spaces of most samples were formed based on octagonal geometry and shape. Also, the dressing room in Qajar baths was larger than the bathing

hall, and on average, the area of the dressing room and the bathing hall in the cold climate was larger than in the warm climate samples, while the total area of the cold climate baths was smaller than the hot climate baths of the province [42].

Pourhaidar Tochahi and Pourashmanan Talami reviewed the role of entrance in the physical system of Gilan baths in the Qajar era. Applying descriptive and analytical research methods, they showed that bathhouses were completely introverted buildings due to the type and manner of their spatial arrangement and function. Also, the orientation of the baths was influenced by the main direction of the city form [43].

Moshbaki Esfahani analyzed the spatial structure of the Qiblah bath in Tehran based on Gestalt rules in an article using descriptive and analytical methods. This study shows that the Gestalt rules have had a significant impact on the physical and spatial structure of the Qiblah bath. According to the study, the principle of symmetry had the greatest effect, while the principles of form, context, and experience had the least effect [44].

2. Materials and Methods

As mentioned earlier, the purpose of this study is to recognize the architecture of the historical baths of Isfahan province from the perspective of physical geometry, and it is trying to answer the question of what are the architectural characteristics of the historical baths of Isfahan province from the perspective of physical geometry?

The current research has a positive and analytical approach to the subject in terms of research methodology and according to the objective. The variables obtained based on documentary studies are the typology of the baths (based on the type and location of the establishment, users, the physical body of the bath, and the shape of the dressing room and bathing hall); spaces and micro-spaces (main, connection, and service spaces), dimensions and proportions (total bathroom area, dressing room area, bathing hall area, and related ratios). The current research focuses on dressing rooms and bathing halls. In twin bathhouses, the features of the large bath were considered in the calculations. Since all samples are located in the hot and dry climate zone of Isfahan, the climate variable was not included in the study.

Among more than 50 historical bathhouses identified in Isfahan province, based on the focus of research on the Safavid and Qajar eras, 37 bathhouses belonging to these two eras have been considered as statistical populations. From among the statistical population, based on the judgment of the researchers, 13 bathrooms were selected as samples in a non-random and non-probabilistic manner. To maintain the validity of the sampling, the following criteria were considered in selecting the studied samples.

- The items were preferably selected from those cases registered in the list of national works; However, one sample (Mohtsham bathhouse) was not registered in the mentioned list and another one (Khosrow Agha bathhouse) had already been destroyed. Yet such samples are worth studying to preserve their documents.
- Cases were selected that had sufficient architectural and artistic values for analytical study.
- Researchers limited the geographical distribution of the samples to two big cities of the province, namely Isfahan the Safavid capital, and Kashan the big city of the province and the one considered significant in the Qajar era.
- The time distribution of samples (in terms of year and era of construction) during the Safavid to Qajar era was also taken into consideration.

Considering the number of indicators under study and the size of the statistical population, the number of samples was determined in such a way that the amount of duplicate data was as low as possible. All the research data are collected through field studies. The research findings have been analyzed with statistical methods. Selected examples are introduced as follows. (Table 2) (Figure 2)

3. Results

The research findings have been categorized and analyzed in three main axes.

1.3. Typology of samples: The sample bathhouses have been examined from the perspective of the type of establishment, the location of the establishment, the users of the bathhouse, and the physical body of the bathhouse, as well as the shape of the dressing room and the bathing hall. (Table 3)

2.3. Spaces and micro-spaces of samples: The spaces and micro-spaces of the selected samples are categorized into three sections; main, connection, and service spaces. Major principles in the relationship between spaces and micro-spaces, i.e. respecting hierarchy (sequence of dressing room, mid-door, and bathing hall) and circulation, have also been considered. (Table 4)

3.3. Dimensions and physical proportions of the samples: Considering the focus of the research on

the two main spaces of the dressing room and bathing hall, the selected samples were examined in terms of dimensions (length, width, and height) and the area of these two spaces, and the related ratios were also calculated. (Table 5)

4.3. Analysis of findings about shape and physical typology: Table 3 shows that:

- In terms of type and location, all selected samples (100%) fall into the category of fixed and urban bathhouses.
- From the point of view of bath users, 12 baths (92.3%) were public bathhouses, six of which were located in the center of the city and the other six in the center of the neighborhood. One bath (7.7%) was considered a private bathroom.
- In terms of physical typology, five of the samples (38.64%) were single bathhouses and eight samples (61.36%) were twin or double baths. No example of triple baths was found in the Isfahan region.
- In terms of the typology of the shape of the dressing room and bathing hall (as seen in Table 1), three of the samples (23.08%) were type I, five baths (38.46%) were type II, three baths (23.08%) were type III, and two others (15.38%) were type IV. On this basis, type II, where both the dressing room and bathing hall are octagonal, is more frequent than other types.

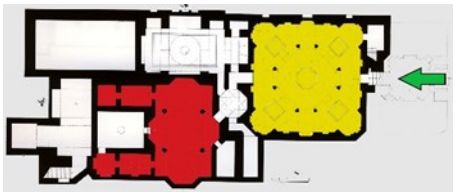
5.3. Analysis of findings about spaces and microspecies: Table 4 shows that:

- From the point of view of the main spaces, all the samples (100%) included a dressing room and a bathing hall, and only seven (53.85%) of the samples had a chal-howz.
- In terms of connection spaces, all the samples (100%) had arched gates and mid-door, and only five of the bathrooms (38.46%) had vestibules.
- In terms of service spaces, all samples (100%) had toilets, a private cleaning room, khazineh, and a furnace. Three baths (07/23) of the samples had corridors.
- In all baths (100%), the principles of spatial relationships (hierarchy and circulation) were considered by the architect.

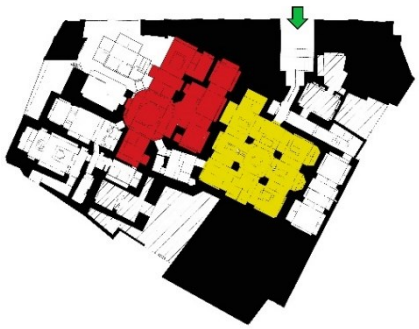
Table 2. Charactristics of the samples.

	Bath Name	Era/ year of building	Founder/ Builder	Reg. No.	Reg. Date	Function	Current State
1	**Jarchibashi**	Safavid era	Malek Sulatan Jarchibashi	11545	2005	Traditional Restaurant	Open
2	**Khan**	Zandiya era (1187 A.H.)	Mirza Qiyas-o-din a causin of Mirza Abdul Razzaq	3627	2003	Museum & Traditional Restaurant	Open
3	**Khosrow Agha**	Safavid era	Khosrow Agha an eunuch of Shah Suleiman's harem	976	1974	---	Ruined
4	**Dardasht**	Safavid era	Agha Momen	15192	2006	Cultural and Artistic use	Open
5	**Rahnan**	Safavid era	Haj Agha Mohammad Rahnani	825	1968	Museum	Open
6	**Shah**	Safavid era	Unkown	7649	2003	Cultural and Artistic use	Open
7	**Shahzadeh**	Safavid era	Shahrbano Beigom, Shah Hossein's daughter	1115	1975	Handicraft Market	Open
8	**Shah Ali**	Safavid era	Unkown	1904	2018	Traditional Restaurant	Open

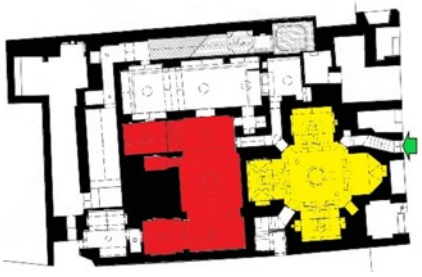
9	**Aliqoli Agha**	1125 A.H.	Aliqoli Agha an eunuch of Shah Suleiman's harem	226	1943	Museum	Open
10	**Fin**	Small bath: Safavid era Large bath: Qajar era	Unkown	238	1935	Museum	Open
11	**Ghazi**	Safavid era	Unkown	26655	2007	Bath	Open
12	**Mohtasham**	Qajar era	Unkown	---	---	Bath	Open
13	**Wazir**	Safavid era	One of Shah Abas's Wazirs	1753	1996	Center for Intellectual Development of Children and Teenagers	Open



2. Khan Bath

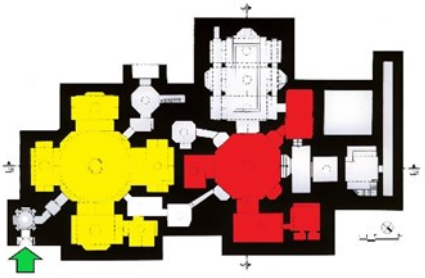


1. Jarchibashi Bath

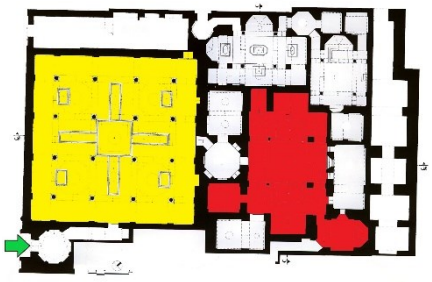


4. Dardasht Bath

3. Khosrow Agha Bath



6. Shah Bath



5. Rahnan Bath

Figure 2. Plans of sample bathhouses.

Table 3. Typology of samples.

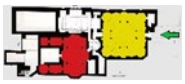
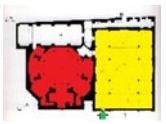
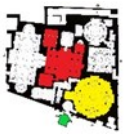
No.	Name	Type		Users	Body Shape	Body Type	Plan
1	Jarchibashi	Fixed	Urban	Public, Downtown	Twin	III	
2	Khan	Fixed	Urban	Public, Downtown	Single	I	
3	Khosrow Agha	Fixed	Urban	Public, Downtown	Single	III	
4	Dardasht	Fixed	Urban	Public, Neighborhood center	Single	IV	
5	Rahnan	Fixed	Urban	Public, Neighborhood center	Single	I	
6	Shah	Fixed	Urban	Public, Downtown	Single	II	
7	Sahzadeh	Fixed	Urban	Public, Downtown	Single	II	
8	Shah Ali	Fixed	Urban	Public, Neighborhood center	Twin	II	
9	Aliqoli Agha	Fixed	Urban	Public, Neighborhood center	Twin	IV	
10	Fin	Fixed	Urban	Exclusive, governmental	Twin	I	
11	Ghazi	Fixed	Urban	Public, Downtown	Twin	II	
12	Mohtasham	Fixed	Urban	Public, Neighborhood center	Twin	II	
13	Wazir	Fixed	Urban	Public, Neighborhood center	Twin	III	

Table 4. Spaces and Micro-spaces.

No.	Bath Name	Main Spaces				Spaces Connection Spaces					Service Spaces					Number of Spaces	Observing Hierarchy	Observing Circulation
		Dressing Room	Shahneshin of dressing Room	Bathing Hall	Shahneshin of Bathing Hall	Chal-Howz	Entrance Porch	Vestibule	Mid-Door	Corridor	W.C.	Private Cleaning Room	Khazineh	Furnace				
1	Jarchi bashi	✓	---	✓	✓	---	✓	---	✓	✓	✓	✓	✓	✓	10	✓	✓
2	Khan	✓	---	✓	✓	✓	✓	✓	✓	---	✓	✓	✓	✓	12	✓	✓
3	Khosrwo Agha	✓	---	✓	✓	---	✓	---	✓	---	✓	✓	✓	✓	10	✓	✓
4	Dardasht	✓	✓	✓	✓	✓	✓	---	✓	✓	✓	✓	✓	✓	12	✓	✓
5	Rahnan	✓	---	✓	✓	---	✓	✓	✓	---	✓	✓	✓	✓	10	✓	✓
6	Shah	✓	✓	✓	✓	✓	✓	✓	✓	---	✓	✓	✓	✓	12	✓	✓
7	Shahzadeh	✓	✓	✓	✓	✓	✓	---	✓	---	✓	✓	✓	✓	11	✓	✓
8	Shah Ali	✓	✓	✓	✓	✓	✓	---	✓	---	✓	✓	✓	✓	11	✓	✓
9	Aliqoli Agha	✓	✓	✓	✓	✓	✓	✓	✓	---	✓	✓	✓	✓	12	✓	✓
10	Fin	✓	✓	✓	✓	✓	✓	---	✓	---	✓	✓	✓	✓	11	✓	✓
11	Ghazi	✓	✓	✓	✓	---	✓	---	✓	---	✓	✓	✓	✓	10	✓	✓
12	Mohtasham	✓	✓	✓	✓	---	✓	✓	✓	✓	✓	✓	✓	✓	10	✓	✓
13	Wazir	✓	✓	✓	✓	---	✓	---	✓	---	✓	✓	✓	✓	10	✓	✓

Table 5. Dimensions and physical proportions of the samples

No.	Bath Name	Area						Dressing room					Bathing hall				
		Total Area	Dressing Room	Dressing Room/ Total Area	Bathing Hall	Bathing Hall/ Total Area	Dressing Room/ Bathing Hall	l	w	h	A	B	l	w	h	C	D
1	Jarchibashi	636.5	100	0.15	15.21	0.02	6.06	10	10	3.75	1	0.37	3.9	3.9	5.35	1	1.37
2	Khan	1186.5	207.36	1.8	70	0.05	2.96	14.4	14.4	4.6	1	0.31	10	7	5	1.42	0.5
3	Khosrwo Agha	730	284	0.39	98.64	0.14	2.88	20	14.2	10.5	1.41	0.53	10.8	10.8	----	1	---
4	Dardasht	615	31.36	0.05	100	0.16	0.3	5.6	5.6	4.7	1	0.83	10	10	3.7	1	0.37
5	Rahnan	1351	576	0.4	192	0.14	3	24	24	6.1	1	0.25	16	12	4.9	1.3	0.30
6	Shah	1049.5	71/17	0.07	56	0.05	1.27	8.7	8.7	9	1	1.06	8	8	7.5	1	0.94
7	Shahzadeh	662	43.36	0.07	40.68	0.06	1.07	6/8	6/8	7.2	1	1.06	6.6	6.6	6.3	1	0.95
8	Shah Ali	805.5	19.36	0.02	31.36	0.03	0.61	4.4	4.4	----	1	----	5.6	5.6	----	1	---
9	Aliqoli Agha	1128	119.5	0.11	79.2	0.07	1.51	12	12	6.6	1	0.55	11	7.2	4.6	1.53	0.42
10	Fin	890	38.2	0.04	77	0.09	0.5	6.7	5.7	5	1.18	0.75	11	7	4.8	1.57	0.44
11	Ghazi	784.5	50.41	0.06	36	0.04	1.4	7.1	7.1	----	1	----	6	6	---	1	---
12	Mohtasham	597.5	40.96	0.06	26.46	0.04	1.54	6.4	6.4	7.2	1	1.1	5.4	4.9	5.5	1.1	1
13	Wazir	2045.5	112.5	0.05	65.24	0.03	1.72	12.5	9	9	1.39	0.72	8.2	8.2	7.5	1	0.91

Notes: A = Ratio of length to width of dressing room; B = Ratio of height to length of dressing room; C = Ratio of length to width of bathing hall; D = height to length ratio of bathing hall.

6.3. Analysis of findings about dimensions and proportions: Table 5 shows that:

- Rahnan Bathhouse had the largest dressing room (576 square meters), and Shah Ali Bath was the smallest one (19.36 square meters). On the other hand, the ratio of the area of the dressing room to the total area of the bathhouse was the highest in Khan Bathhouse (1.8). The length-to-width ratio of the destroyed dressing room of Khosrow Agha bathhouse shows the highest value in the studied samples with 1.07. The height-to-length ratio of the dressing room was the highest in Mohtsham Bathhouse (1/1).
- Rahnan Bath had the largest bathing hall (192 square meters), and Jarchibashi Bath had the smallest (15.21 square meters). The ratio of the area of the bathing hall to the total bathhouse area is the highest (0.16) in Dardasht Bathhouse. The ratio of length to width of Fin bathing hall shows the highest value (1.57) in the studied samples. The ratio of the height to the length of the bathing hall is the highest in the Jarchibashi bath (1.37).
- The ratio of the area of the dressing room to the bathing hall shows the highest value in Jarchibashi bath (6.6) and the lowest value in Dardasht Bath (0.3).

Table 6. Analysis of sample bathhouses in terms of dimensions and proportions.

	Total Area	Dressing Room Area	Bathing Hall Area	A	B	C	D	E	F	G
Max	2045.5	576	192	1.8	0.16	6.6	1.41	1.1	1.57	1.37
Average	960.11	130.32	66	0.3	0.07	1.9	1.07	0.68	1.12	0.72
Min	597.5	19.36	15.21	0.02	0.02	0.3	1	0.25	1	0.3

Note: A= Ratio of dressing room area to bath total area; B= Ratio of bathing hall area to bath total area; C= Ratio of dressing room area to bathing hall area; D= Ratio of length to width of dressing room; E= Ratio of height to length of dressing room;
F= Ratio of length to width of bathing hall; G= Ratio of height to length of bathing hall.

4. Discussion

Research findings about the physical typology show a lot of similarities with other similar studies, although sometimes differences are also visible. Tabassi et al. showed that 40% of the bathhouses were twins, while in the present study, more than 60% were twins [31]. It seems that the construction of twin baths, which had its roots in jurisprudence [33], began in the Safavid era and increased in the Qajar era.

In terms of the typology of dressing room and bathing hall, the present study shows that although the dominant shape in dressing room and bathing hall was octagonal, in more than 60% of cases the quadrangular shape was considered next to the octagonal. Similar results were obtained in the study of Mashhad baths, with the difference that in the Safavid baths of Mashhad, the pentagonal shape was also used in the mentioned spaces [41].

Regarding the microspaces of bathhouses, the findings of the present research show some differences with other studies. According to Tabassi et al., 70% of Safavid baths had a chal-howz [31], while this number decreases to about 54% in the present study. Also, according to the same study, vestibular space was seen in 50% of the samples and this amount was reduced to about 38% in the present study. It seems that during the Qajar era, the construction of the chal-howz and vestibule was less favored by architects.

From the perspective of the dimensions and proportions of the baths, the present study shows significant differences between the baths of Isfahan and other parts of the country. The average area of bathhouses in Fars Province is about 265 square meters [42], while according to this study, the average area of bathhouses in Isfahan is more than 960 square meters. The size of the baths in the Isfahan region can only be justified by the fact that Isfahan was the capital of the country in the Safavid era.

The present study shows that the average ratio of the area of the dressing room to the total area of the bathhouse is 0.3, which is 0.2 more than the similar study by Tabassi et al. [31], and this can be seen as an indication of the expansion of the dressing room space in the Qajar era, while in the same comparison, the average ratio of the area of the bathing hall to the total area of the bathhouse has not changed.

In a similar study, the average length and width of the dressing room and bathing hall of the Safavid baths in Mashhad is about 2 meters less than the baths in other parts of the country. In other words, the main spaces of Mashhad baths are smaller compared to similar examples, which may be due to the relatively cold and dry climate of Mashhad. In addition to the dimensions, even the proportions governing the dressing room and bathing hall in the Mashhad baths also show a significant difference from the baths in other parts of the country [41].

5. Conclusion

All the findings and their analysis are actually the answer to the research question and show the characteristics of the architecture of Isfahan baths. According to Table 4, all the studied baths are similar as far as the main spaces, connection spaces, and service spaces are concerned. However, some micro-spaces are not seen in all bathrooms, for example, the chal-howz was observed in seven cases, the vestibule in five cases, and the corridor in only three cases. Contrary to the fact that Isfahan is located in a hot and dry climate, the construction of chal-howz was not customary in all cases, and it seems that it was dependent on other factors besides the climate. The absence of a vestibule and corridor in most samples cannot be justified and needs further study.

As can be seen in Table 5, although Wazir Bath is the largest bath, the largest dressing room and bathing hall belong to Rahnan Bath. The present study shows that, unexpectedly, in the

city of Isfahan, the capital of the province and the capital of the Safavid era, the baths in the neighborhood centers were larger than the baths in the city center.

As can be seen in Table 6, the largest bath (Wazir Bath) is more than 3 times bigger than the smallest one (Dardasht Bath). The area of the largest dressing room (Rahnan Bath) is more than 19 times larger than the smallest one (Shah Ali Bath), and this ratio is more than 12 times in the bathing hall of Rahnan Bath (the largest) and Jarchibashi Bath (the smallest). The significant difference between the area of the baths and the area of the dressing room and bathing hall shows that the size of the baths was a function of the population of the bath area and the urban location (city center or neighborhood center), while the physical type of the bath and other factors did not play a role in it.

As seen in Table 6, the ratio of the dressing room area to the total area of the bathhouse varies from 0.02 to 1.8. The ratio of the area of the bathing hall to the total area of the bathhouse varies from 0.02 to 0.16. This means that compared to the bathing hall, the dressing room was much wider in terms of space utilization. But the results show that, contrary to expectation, the height-to-length ratio in dressing rooms is lower than the same ratio in bathing halls, that is, the wide space of the dressing rooms has a shorter height. The closeness of the ratio of length to width in dressing rooms and bathing halls shows the uniformity and harmony of the shape of the said spaces.

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