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An investigation into the building-sanitary equipment in the traditional residential architecture

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Despite the developments and changes in the constructional domain, most of the best construction materials of the past are still the best and the buildings of the past have still been superior to the present buildings. In such a case, the traditional must be stuck to and traditional solutions must be taken as examples. Therefore, this study investigated the building-sanitation-related elements (water disposal systems, heating and chimney systems and drainage systems) and their uses in the traditional houses (their characteristics, the changes in their uses and the extent of these changes). The study also attempted to find out the principles and criteria on which the arrangements that are the products of accumulated experiences were based in the spaces or systems. Furthermore, the study investigated how and at what level the new equipment that the new age presents are reflected in the traditional house. The dimensional, positional, directional, constructional, equipment and material characteristics of these elements were investigated in accordance with the knowledge, theories and principles of architecture and instructive data about these were obtained from the traditional houses. The traditional houses in the city of Trabzon (Turkey) were chosen as the sample area of work.

Key words: Water disposal, heating and chimney systems, drainage system, equipment and material characteristics, traditional houses.

INTRODUCTION

In order to improve the comfort conditions in the space that separates man from the physical environment to a suitable state, some auxiliary equipment is needed. Buildings must have heat, water and moisture insulations and there should be enough ventilation. There must be enough skylight and heat (Ranson, 1991; Heyman et al., 2005; Jones et al., 2007). Fresh water, one of the most important needs, must be brought into the building and waste water must be taken away from the building and in this way building conditions must be improved to make the use of different systems possible (Peter et al., 2002).

Building construction is a biological process, not an aesthetic one (Meyer, 1991). A building must, first and foremost, respond to a function and this requires the building not to fail in its use in any way. However, a successful building is in terms of aesthetics, if it does not

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perform this function, it can never be a healthy building (Ineichen, 1993, Zhong et al., 2012). Protection from the unwanted conditions of the physical environment is the most important need of man (Novoselac and Siegel, 2009). The above mentioned factors must be controlled through the help of building elements.

According to Özdeniz (1978), it is possible to remove the unwanted climatic variables from the building by the following:

(1) Allowing enough of them to permeate in the building if they are necessary for the user's comfort,
(2) Allowing the excess of them to permeate in the building if prevention of the possible effects of them is not economical,
(3) Removing the rest of them from the building by controlling the forces that enable permeation.

At the time when there were no mechanical tools to control the physical environment and when building materials were simple raw materials, climate was a very important factor in the formation of buildings. Especially the buildings which were designed and built by the users show how wisely the climate can be controlled for a livable environment (Van den Bulcke et al., 2009; Huijbregts et al., 2012). Archaeological findings and modern day primitive examples have shown that the roof and roof covers, which are constructed to protect the user and building from the atmospheric effects, have been considered throughout the history as the most important things in terms of its importance in the whole of the building (Nauman, 1991). The traditional building materials and construction systems used in house construction have not changed remarkably until now (Edwards et al., 2005; Forrest and Izuhara, 2012). The natural materials found in the immediate surroundings of the building make up all kinds of building materials and therefore they are the main components of the building (Arthur, 1999; Ravetz and Turkington, 1995; Ravetz, 2001; Laidley, 2013). In today's buildings and in the buildings that have come from the past to the present day, the same building-sanitary equipment that is shaped by the same principles has been used.

Buildings consist of many elements that have different characteristics depending on their functions in the house. Depending on their functional characteristics, these elements can be classified as follows:

(1) User-related building elements,
(2) Building-related building elements,
(3) User- and building-related building elements (Berksun, 1979; İpekoğlu et al., 2007; Denison and Ren, 2012).

The possibilities that the new age presents change of the user demands and needs. As a result of this change, traditional houses undergo some modern adaptations that aim to meet the needs of modern life. This results in the removal of the traditional borders between the social groups at cultural, national and even local level (Dickens, 1988; Mazumdar, 1997; Kim and Kaplan, 2004; Youngen and Hostetler, 2005; Clark and Kearns, 2012).

This study aims to probe into the elements that are important for man and therefore for the building which accommodates man; that give the building a livable quality; and that are called building-sanitary equipment. The study investigates the needs of a building regarding sanitation, hygiene and comfort, and investigates these factors which will provide the environmental conditions to be evaluated and controlled. With a correct evaluation of the above-mentioned factors, buildings that have no technical failures in terms of vitally important uses must be built. As a result of the provision of these uses in the building and of the evaluation and control of these factors in the building, the building is equipped with some systems. Water disposal systems, fresh water systems, waste water systems, heating and chimney systems which are known as building-sanitary equipment and of which each architect should have full knowledge were conceptually discussed.

The study investigates the relationships between life and built-up environment in terms of building-sanitary equipment in the traditional houses. Another issue that this study investigates is the presence of suitability and unsuitability in the applications of the building-sanitary equipment and whether there are concrete and applicable solutions. The study also investigates the reflections of the possibilities that the modern life presents for the buildings, types of application and the direction of the preferences. The study covers such areas in the traditional houses as:

(1) Water disposal,
(2) Fresh water-waste water and
(3) Heating and chimney systems.

FIELD WORK

The field of work of this study is the traditional houses in the historical settlements in the city of Trabzon in the Eastern Black Sea region of Turkey (Figures 1 to 3).

During the selection of the sample houses, attention was paid to the following:

(1) The selection of the houses that were built before 1940,
(2) The identification of the neighborhoods which were intensely populated by traditional houses,
(3) Whether the houses had the characteristics of the traditional urban houses of Trabzon.

The reason for choosing the houses that were built before the industrial revolution in Turkey is to find out about the reflections of the industrial products in the traditional houses in terms of building-sanitary equipment

The study informs us of the users, preferences for and applications of building-sanitary equipment and questions the extent of the suitability of these preferences.

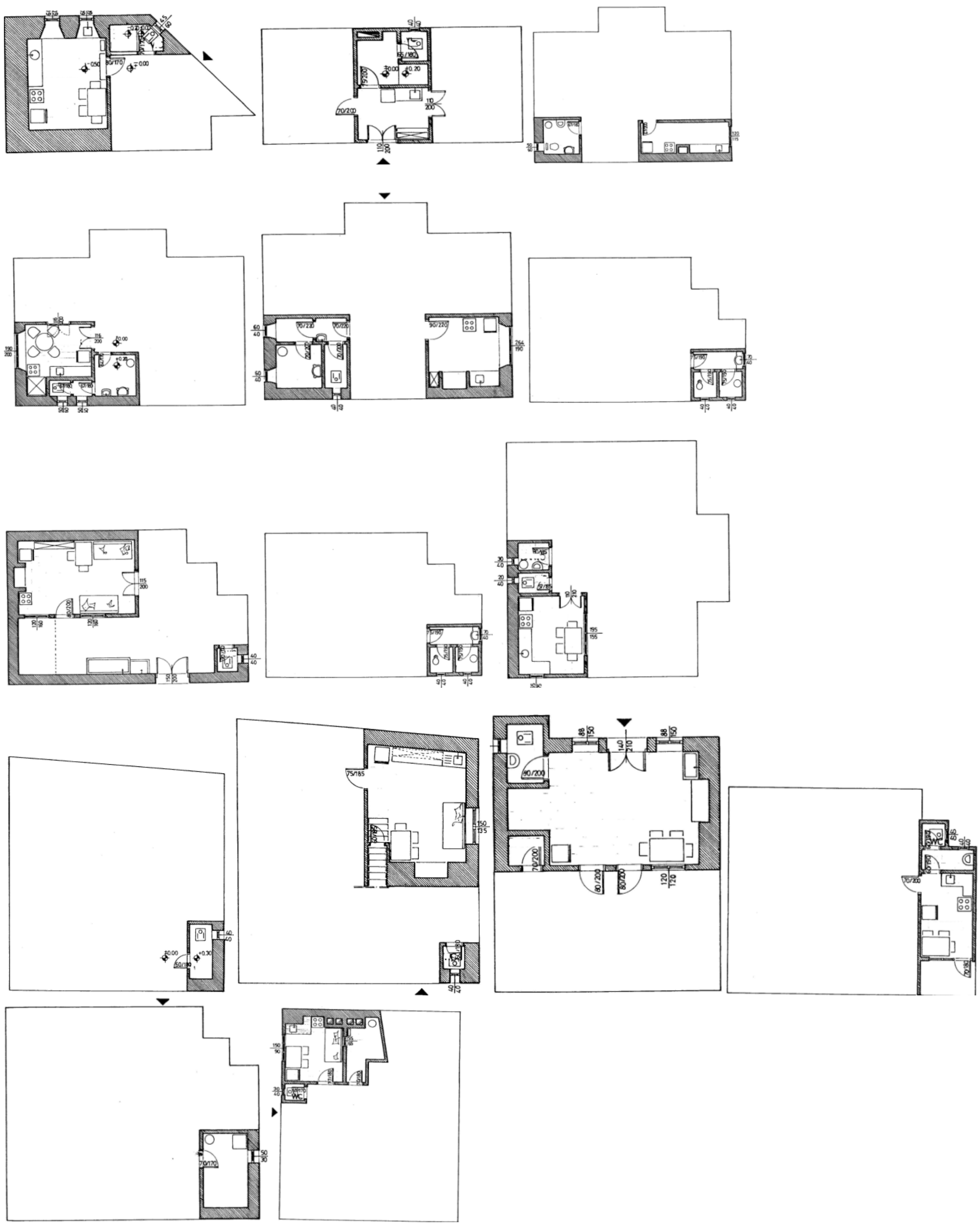

Figure 1. Plans of the building–sanitary equipment in the sample houses studied.

Figure 2. Plans of the building–sanitary equipment in the sample houses studied

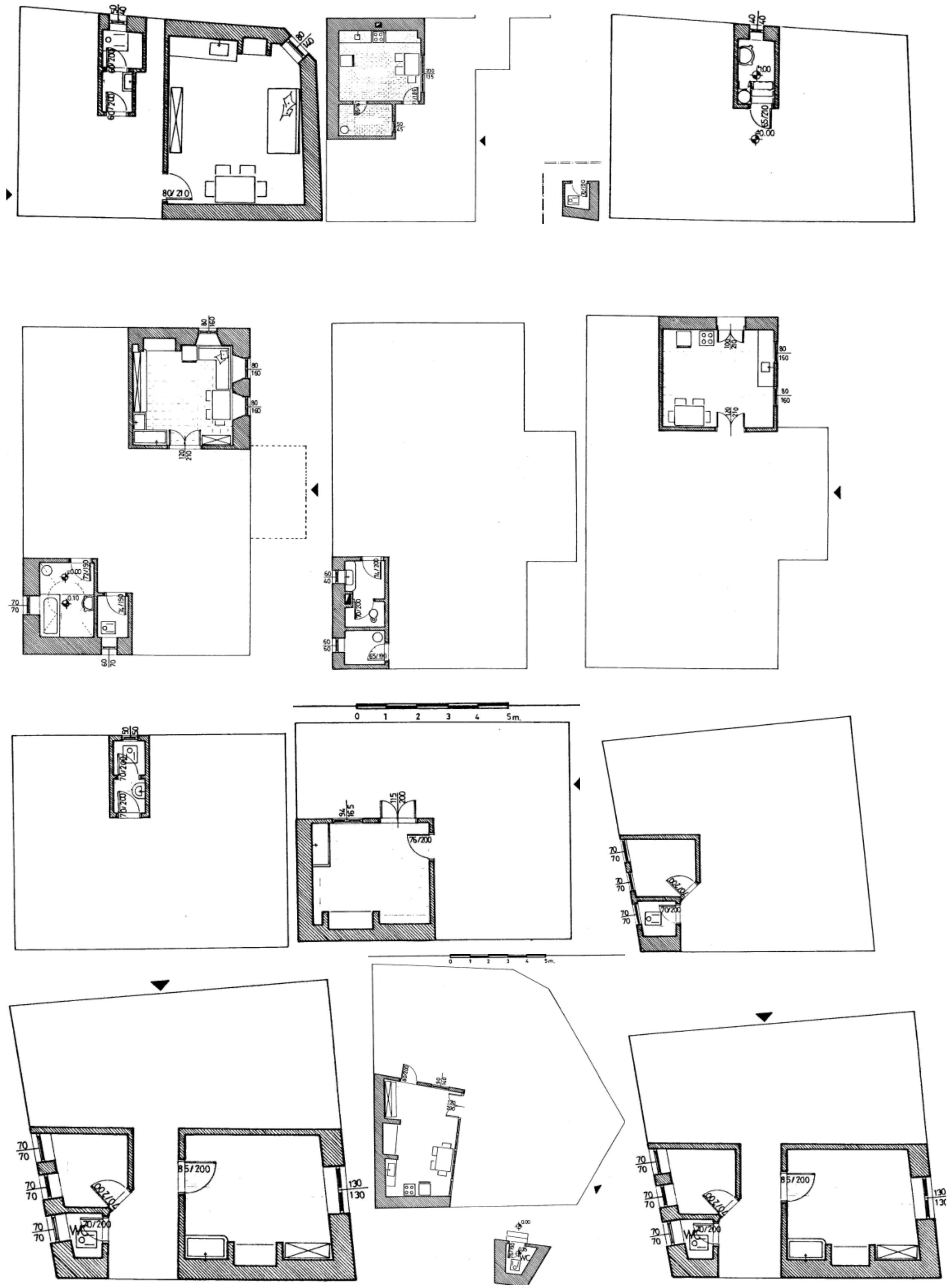

Figure 3. Plans of the building–sanitary equipment in the sample houses studied.

Methods

This study is a field work that aims to investigate building-sanitary equipment in the traditional houses. During the implementation process of this study:

(1) The related literature was reviewed and the details of the aims of building-sanitary equipment were identified,
(2) A questionnaire was developed in order to gather data about the general characteristics of the building-sanitary equipment in the traditional houses that this study investigated,
(3) The sample houses in the study were selected with the observation technique,
(4) The data that were obtained through observation, interview and identification about the general characteristics of the sample houses and about the building-sanitary equipment in the sample houses were recorded in the questionnaire and the measured drawings of the relevant spaces were taken in order to identify their institutional and technical arrangements.

By evaluating the data obtained, the following were intended to be made clear:

(1) The consistencies and contradictions of the applications at system level,
(2) The dimensional characteristics of the elements at space level,
(3) The preferred sizes of the various equipments and the degree of the accuracy of preferences,
(4) The consistencies and contradictions of the elements at system and space level in terms of material, size and application,
(5) The consistencies and contradictions of the new possibilities (products) in the applications at the level of building-sanitary equipment in the traditional houses and,
(6) Putting forward the special and general cases at the level of building-sanitary equipment and drawing conclusions about the comfort conditions in the traditional houses.

Designing the questionnaire

The aim of the questionnaire is to identify the general characteristics of the traditional houses (Appendix), and it consists of four parts:

(1) Information on the structural characteristics: This part contains 7 items which aim to identify the general characteristics of the traditional houses and which elicit data about the construction system, direction and material characteristics of the traditional houses.
(2) Roofs and water disposal: This part contains 9 items which aim to elicit data about: the roof forms and materials; characteristics of the eaves; the materials and diameters of the rain gutters and downspouts; and users' thoughts and reflections about the houses.
(3) Heating and chimney systems: This part contains 19 items that aim to identify the materials and technical characteristics of the heating and chimney systems, and to elicit the users' complaints from, and expectations for, the houses.
(4) Drainage systems: This part contains 5 items which aim to identify the plumbing systems to get water into the buildings and sanitary discharge systems, and the characteristics of these systems.

General information about the traditional Trabzon houses

The local architecture is of a character which has completed its evolution and which has started to disappear. This traditional architecture is known to be a superior architecture at its time (Gür, 1990). The houses that reflect the traces of a rich historical background show different characteristics in the areas in which they were built. Although the building materials are the same, the construction techniques and building formations show variety from region to region; however, each region makes its deep-rooted construction tradition felt and continues this tradition. The most obvious evidence of this continuity is the old urban houses themselves that have come down to the present day (Güngör, 1987).

The houses are the products of a heavily forested region with ample rain. Until the end of the 18th century, the open-sofa plan type was used and later on the inner-sofa and central-sofa plan types became common (Akok, 1991; Gürer, 1994). The walls of the houses that face the north are usually blind. The entrances are usually protected from winds. In the houses, large sofas were built so as to face the east and everything was made to make use of the large scenery. Large sofas face the well-designed courtyards and the daily activities take place in this space. In the traditional houses, upper floors are usually used as living spaces and the ground floors are used as service spaces (Sümerkan, 1990). However, ground floors have undergone tremendous changes in the modern day.

The climate in the Eastern Black Sea region is very rainy, mild and humid (Özdeniz, 1987). In a very rainy and highly humid climate, a scattered settlement pattern was adopted for good ventilation of the houses (Orhan, 1994). There are a lot of diagonal windows so as to allow ventilation. The plans of the houses are zigzagged so as to let the hot air in the summers leave the house easily. The walls of the ground floor are made of stone due to the dampness of the soil. Upper floors are usually made of wood in order to prevent the accumulation of hot air in the summers.

FINDINGS OF THE FIELD WORK

Here, the study presents water disposal systems, fresh water systems, waste water systems, heating and chimney systems and their conditions.

Water disposal systems

Roofs are the uppermost parts of the buildings and protect the buildings against rains and atmospheric effects (Kindangen et al., 1997; Kharrufa and Adil, 2008). With the help of the shaped outer cover, rainwater is channeled to the ground and therefore is removed from the building. Removal of the water from the building is achieved by discharging water through elements that are placed slope-wisesone on another (Fawcett et al., 2008; Bitsuamlak et al., 2009).

Water disposal in building eaves is based on removing water from the building with the help of projections. Even the smallest horizontal projections are effective in removing the rainwater from the building walls. As well as the width of the eaves, the correct detailing of the eaves is very important for water disposal. The widths and forms of the eaves are determined by the climatic conditions, building culture and roof construction in the region in which they are applied (Hasol, 1988).

In order to remove the rainwater and snow water from the roof, rain gutters and downspouts are also used. Collecting rainwater or snow water from the rain gutters, channeling them to the ground or connecting them to

Table 1. The roof characteristics of water disposal elements.

Roof characteristics		Number of houses	Percentage (%)
Roof type	Hipped roof	21	84
	Gable roof	4	16
Use of the loft	Used	5	20
	Not used	20	80
Gutter material	Zinc	10	40
	PVC	10	40
	No gutters	5	20
Downspout material	Zinc	8	32
	PVC	11	44
	No downspouts	6	24

sewage pipe is achieved through downspouts. Rain gutters and downspouts are made of zinc, galvanized sheet or plastic. The water disposal elements are explained as follows:

(1) Roof types: Two types of roof were found to be used in the traditional houses. When the distribution of the roof types in the traditional houses was investigated, it was found that 84% of them are hipped roofs and 16% are gable roofs. Gable roofs are usually used in the buildings with regular plan types. On the other hand, hipped roofs are used in the houses without regular plan types as well as in the houses with regular plan types (Table 1).
(2) Roof covers: It was found that roof tiles were used as the roof cover material in all urban houses that were included in the study.
(3) Eaves width: The average width of the eaves in the traditional houses was found to be 44.4 cm. The narrowest eaves were found to be 10 cm, and the widest to be 120 cm.
(4) The use of the lofts: It was found that lofts are used in 20% of the traditional houses and not used in 80% of the houses. It was found that lofts in the houses in which they are used are used for storage purposes (Table 1).
(5) Rain gutter materials: It was found that the rain gutter materials that are used in traditional houses are zinc and plastic. In the houses which have undergone repairs, zinc rain gutters are replaced by PVC rain gutters. In all traditional houses, zinc rain gutters had been used before repairs. During the repair, PVC rain gutters are preferred due to their low cost and easy availability instead of zinc which requires a lot of labor and therefore, which costs more (Table 1).
(6) Downspout materials: It was found that 24% of the traditional houses do not have downspouts. These houses do not have rain gutters either. The reason for this is that the downspouts come off in time due to various factors and they are not replaced by the new ones. In some houses, the rain gutter and downspout materials are different. This reason for this is that although the downspouts that came off were replaced by the new ones with new material, the rain gutters were not (Table 1).
(7) Rain gutter diameters: The diameter of the rain gutter should be 1 to 0.8 cm^2 for each m^2 of the roof surface area where the rainwater is collected (Anonim, 1987).

Roof surface area (m^2) / rain gutter diameter (cm^2) = 1 - 0.8

It was found that the rain gutters in all traditional houses were half-round (semi-circular) (Table 2). According to this, 20% of the traditional houses do not have rain gutters and the diameters of the rain gutters in 20% of the traditional houses are adequate.
(8) Downspout diameters: The diameters of the downspouts should be 1 cm^2 for each m^2 of the roof surface area where the rainwater is collected.

Roof surface area (m^2) / downspout diameter (cm^2) = 1

The proportional values obtained by the division of the downspout diameters by the roof surface areas are shown in Table 3. According to this, it was found that:

(1) 24% of the traditional houses do not have downspouts
(2) The diameters of the downspouts in 12% of the traditional houses are adequate
(3) The diameters in 64% of the traditional houses are not adequate

It was observed that the necessary requirements for water disposal from the houses are provided. The eaves widths that have important functions show a wide range where the smallest and largest values are found together. Rain gutters are usually more durable than the downspouts. It may be inferred that this is caused by the number of repairs that the downspouts undergo. This

Table 2. Adequacy of the gutters.

Sample No.	Roof surface area (m^2)	Gutter cross-sectional area (cm^2)	Rate (m^2)/(cm^2)	Adequacy
1	136	88	1.55	Inadequate
2	89	88	1.01	Adequate
3	72	66	1.09	Adequate
4	141	–	–	–
5	146	56	2.61	Inadequate
6	178	–	–	–
7	63	66	0.95	Adequate
8	196	88	2.23	Inadequate
9	142	61	2.33	Inadequate
10	141	61	2.31	Inadequate
11	96	66	1.45	Inadequate
12	74	72	1.03	Adequate
13	180	88	2.05	Inadequate
14	140	48	2.92	Inadequate
15	65	61	1.06	Adequate
16	105	88	1.19	Inadequate
17	143	88	1.63	Inadequate
18	125	88	1.42	Inadequate
19	104	88	1.18	Inadequate
20	114	–	–	–
21	115	94	1.22	Inadequate
22	114	88	1.30	Inadequate
23	121	66	1.83	Inadequate
24	60	–	–	–
25	337	–	–	–

may be caused by some inadequacies in application or by the fact that downspouts are more prone to the atmospheric effects.

Heating and chimney systems

When the minimum thermal difference between a healthy person's body temperature (Eker, 1991) and the environmental temperature is 20 to 23°C, it is considered to be the ideal temperature n the natural environmental conditions cannot provide this, the adequate level of temperature is obtained through heating in the inner spaces (Wall, 1973; Bae and Chun, 2009; Liu et al., 2009). Among the important factors that affect the heat in the houses are the building types (detached house, semi-detached house, terrace house), direction (of the rooms, that is, facing north, south, etc), thermal process of the building and the design of chimney elements (Baytin, 1951; Chen et al., 2009).

According to this, the following are the factors that reduce the chimney draft:

(1) Inadequate chimney height,
(2) Low smoke heat,
(3) High outer temperature,
(4) Long chimney surface area,
(5) Incorrectly built chimneypots,
(6) Larger- or smaller-than-necessary chimney diameters.

Among the chimney types are stove chimneys, fireplace chimneys, kitchen chimneys and some other chimney types (central heating chimneys, natural gas stove chimneys, Turkish bath chimneys, industrial chimneys, ventilation chimneys, and refuse chimneys).

It was found that heating in the traditional houses is achieved through single heating tools such as stoves and that the main heating fuels are the traditional fuels such as wood, coal, and hazelnut shells. However, high-tech heating tools and fuels are also commonly used in the above-mentioned houses. The fireplaces which were once the center of the house and around which the daily activities were once carried out have lost their significance and are not used any more. The center of the house is the section of the house which is used as the living space and which is usually called the living room. In the traditional houses, the priority is given to the heating of these spaces.

Table 3. Adequacy of downspouts.

Sample No.	Roof surface area (m^2)	Downspout cross-sectional area (cm^2)	Rate (m^2)/(cm^2)	Adequacy
1	136	79	1.72	Inadequate
2	89	50	1.78	Inadequate
3	72	64	1.13	Inadequate
4	141	–	–	–
5	146	39	3.74	Inadequate
6	178	–	–	–
7	63	79	0.78	Adequate
8	196	79	2.48	Inadequate
9	142	44	3.23	Inadequate
10	141	79	1.78	Inadequate
11	96	44	2.18	Inadequate
12	74	79	0.94	Adequate
13	180	79	2.28	Inadequate
14	140	–	–	–
15	65	79	0.82	Adequate
16	105	79	1.33	Inadequate
17	143	123	1.16	Inadequate
18	125	79	1.58	Inadequate
19	104	79	1.32	Inadequate
20	114	–	–	–
21	115	79	1.46	Inadequate
22	114	79	1.32	Inadequate
23	121	50	2.42	Inadequate
24	60	–	–	–
25	337	–	–	–

Table 4. Heating systems and use of fireplace.

Heating and chimney systems		Number of houses	Rate (%)
Heating system	Central heating	–	–
	Single heating	25	100
Use of fireplace	Yes	–	–
	No	25	100

The chimney system is usually found in the spaces where the fireplace is. There may be chimney systems in the heated spaces; however, there may not be chimney systems in such spaces and the smoke here may be discharged by using stovepipes extending outside through a chimney hole that is opened in a suitable wall or window. There is also a small number of examples of other spaces which have chimney systems as follows:

(1) Heating systems: It was found that spaces in the traditional are heated by single heating tools. There are no central heating systems in any of the traditional houses in this study (Table 4).

(2) Use of fireplaces: Until recently, fireplaces had an important place in the traditional houses; however, they are not used any more (Table 4). Instead of these fireplaces which also have the heating function when cooking, newer cooking tools are preferred due to some practical concerns. Furthermore, instead of using the fireplaces for the purpose of heating the space, various other heating tools are preferred.

(3) Number of chimneys: The average number of chimneys in the 25 traditional houses in this study is 2.08 (Table 5).

Table 5. Chimney forms.

Variable	Characteristics	No. of chimneys	Percentage (%)
Chimney form	Square	34	65.39
	Rectangular	16	30.77
	Circular	1	1.92
	Polygonal	1	1.92
Chimney material	Brick	33	63.46
	Stone	18	34.62
	Concrete	1	1.92
Chimney characteristic	Single chimney	44	84.62
	Grouped chimneys	8	15.38
Chimney position	Inner wall	5	9.60
	Outer wall	47	90.40
Chimney height	Above the ridge line	37	71.11
	Not above the ridge line	15	28.89
More than one connection to a chimney	Yes	6	24
	No	19	76
Chimney–wall materials	Stone-stone	20	38.47
	Brick-stone	14	26.92
	Brick-infill	14	26.92
	Brick-brick	3	5.77
	Stone–concrete	1	1.92

(4) Chimney forms: Various chimney forms were found in the traditional houses and their distribution is given in Table 5. By the chimney form, the form of the horizontal diameter of the chimney is meant. Circular chimney form which has the best chimney draft was found only in one sample. The polygonal form, too, has a good draft like the circular form. Stone and brick are the most commonly used building materials for the chimneys. Therefore, because of the ease of their use in application, rectangular or square forms are preferred, which affects the preferences in terms of forms of the chimneys. Square form was found to be the most common chimney form in the traditional houses.

(5) Chimney materials: The materials used for the construction of the chimneys are not different from the materials used in the construction of the building. The most common building material used in chimneys are stone, brick and concrete. When we have a closer look at the proportional distribution of the materials used in the chimneys of the sample houses, we see that stone and brick are the main building materials (Table 5). Brick has the highest rate of heat insulation and is the most suitable chimney material. Therefore, it has been preferred as the material in the construction of chimney element in the majority of the traditional houses.

(6) Grouped chimneys: Of the 52 chimneys in the traditional houses that the study investigated, 8 have the characteristic of grouped chimneys (Table 5). It can be said that 15.3% of the traditional houses have correct and conscious chimney applications.

(7) Walls on which chimneys are built: The majority of the houses that were investigated have stone walls to which the houses lean and which surround the houses on one or more sides. The fireplaces are usually built on one of these stone walls, and the chimneys reach up the roofs along these walls. Because wood is widely used in the traditional houses, chimneys are built on these stone or brick walls. When we consider the infill walls with wooden bases, chimneys are built on the outer walls (because wood is not heat resistant) (Table 5).

(8) Chimneypots: In all chimney applications in the traditional houses, chimneys have pots.

(9) Chimney heights: In order for a correct chimney draft to take place, the chimney must be at least 50 cm higher than the highest structure around the chimney and then the roof ridge (Baytin, 1951). In 71.11% of the houses that were investigated, the chimneys are not higher than the roof ridges. It is a well known fact that the majority of

chimneys are built on the outer walls. In this case, in order for the chimney to be higher than the roof ridge, the trunk of the chimney must be very long (Table 5). A long chimney trunk negatively affects the load bearing and drafting of the chimney. However, this should not create any problems considering the fact that chimneys are usually built on the outer walls; that this requires the chimney to be higher than the roof ridge and then any structure around the chimney on the roof; and that the chimney can get enough wind.
(10) Chimney diameters: In all chimneys in the traditional houses that were investigated, it was found that the vertical diameters of the chimneys are the same along the chimney heights.
(11) Connections to the same chimneys: Chimneys function well when maximum three stovepipes are connected to the same chimney from different floors and two stoves from the same floor. It was found that there was only one stove or stovepipe connection to the same chimney in 76% of the traditional houses and that there was more than one connection to the same chimney in 24% of the houses.
(12) Spaces with chimney systems: No samples without chimney systems were found in the field of work (Table 6). The spatial distribution of the 59 chimneys in 25 traditional houses is given in Table 7. When we look at the distribution rates of the chimneys in terms of spaces, we see that 40.68% of them are in the kitchens, 25.42% in the bathrooms, 22.03% in the living rooms, and 11.87% in the bedrooms.
(13) Chimney systems found in the heated spaces: In the traditional urban houses, the rooms without chimney systems are also heated (Table 8). If there are no chimneys in the heated spaces, the stovepipes are extended to the outside by opening a hole on a suitable wall or window. When we look at the distribution of the chimney systems in the traditional houses, we see that 69 spaces are heated in 25 houses and 85.50% of these spaces have chimneys. 14.50% of these spaces do not have chimney systems.
(14) Chimney weep holes: The soot accumulated in the chimneys is cleaned easily through weep holes that are opened on the chimney trunks a little higher from the ground on each floor. However, no houses that the study investigated have chimney weep holes.
(15) The materials of the chimneys and walls on which chimneys are built: The materials of the chimneys built on the stone walls in the traditional houses can be either stone or brick. The material of all the chimneys built on infill walls or brick walls is brick. On the other hand, only one house has a concrete chimney, and this chimney was built on stone (Table 5).

In real terms, there is only one chimney in each house. Chimneys are found in the kitchens which are the centers of the houses and where the fireplaces are. All of the chimneys in the traditional houses reach the outside environment. The chimney elements in the houses have usually been applied correctly.

Drainage system

The most important element of building-sanitary equipment is water. A drainage system consists of getting the water in (fresh water) into the house, branching it to the spaces where it is used, and the waste water (foul water) (Gormley and Campbell, 2007). The oldest pressurized water transportation installation was found in Northern Syria (Nauman, 1991). In old settlements, as in some examples of modern day rural areas, there was a well almost in each courtyard (Ögel, 1978). Great care was taken when getting the drinking water. The same care was taken when draining the wastewater and rainwater. In suitable areas, leakage pits were dug. Depending on the tools that existed at the time, different sewer systems were built. Conic telescopic clay pipes with oval weep holes took the waste water from the storage pits, passed it through the lower pipe, and conveyed it to a sewer system which was covered with huge stones and whose flow was away from the city gates (Hasol, 1988).

Getting water into the building can be achieved in 4 ways. These are:

(1) Old type of water installation with a water tank in the loft,
(2) Manually pressurized tanks in the basement,
(3) Electrically pressurized water tanks in the basement,
(4) Electrically pressurized automatic water tanks (air pressure water system) in the basement (Nauman, 1991).

The pipes to be used in the fresh water installation in the houses must be rustproof. The whole domestic water installation must be installed horizontally slightly elevating towards the place of use, airlocks must be avoided and there should be water relief valves at the highest points of the installation (Anonim, 1987). Regional operating pressure, length of pipes, flow and flow rate are important in choosing the right pipe sizes (Sahal and Lacasse, 2008; Huang et al., 2009).

A sewer system is needed in order to remove or neutralize the waste water and rain water collected in different buildings and in different places. Waste water is usually connected to the city sewer system through pipes or cement pipes laid underground. If there is not such a sewer system in a city, cesspools are built for individual houses or groups of houses (Anonim, 1987).

As much as possible, waste water pipes should be without twists and turns. The main pipes should be freeze-resistant and must be installed at least 3 m away from the potable water sources. Furthermore, there should be weep holes in the waste water installation in

Table 6. Spaces with chimney systems.

Sample No.	Kitchen	Bathroom	Living room	Bedroom	Bedroom
1	*				
2	*				
3	*		*		
4	*	*	*		
5	*		*		
6	*				
7	*	*			
8	*	*			
9	*		*		
10	*	*	*	*	
11	*	*	*	*	*
12	*		*		
13	*	*			
14	*			*	
15	*	*			
16	*	*	*		
17	*	*			
18	*	*			
19	*				
20	*		*		
21	*	*	*		
22	*	*			
23	*	*	*		
24	–	*	*		
25	*				

Table 7. Distribution of chimneys according to spaces.

Spaces with chimney systems	Number of spaces	Percentage (%)
Kitchen	24	40.68
Bathroom	15	25.42
Living room	13	22.03
Bedroom	6	10.17
2nd bedroom	1	1.70

order to be able to repair any possible clogging and to regularly check the system.

(1) Cisterns: 20% of the traditional houses that the study investigated have cisterns and they are used for various purposes except for drinking. 80% of these houses do not have cisterns; although cisterns were identified in some examples, it was found that they did not have any functional uses (Table 9).
(2) Wells: It was found that 32% of the sample houses have the element of well and 38% don't (Table 9). It was also found that 37.50% of the identified wells were sealed so as not to be used again, 25% of them were sealed and not used though they had water in them, and 37.50% had water which was used for various uses except for drinking when the city water was cut. The well water was never used as drinking water.
(3) Getting fresh water into the building: In all houses, both the potable water and utility water are provided by the city water supply network.
(4) Disposal of waste water from the house: Disposal of waste water from the houses is achieved through a connection to the city sewer system. No other types of waste water disposal system were found in the traditional houses that this study investigated.

The study, which aimed to investigate the building-sanitary equipment in the traditional houses in Trabzon,

Table 8. Chimney systems in the heated spaces.

Sample No.	Kitchen	Bathroom	Living room	Bedroom
1	C	O	O	–
2	C	O	–	–
3	C	C	C	–
4	C	C	C	C
5	C	C	C	C
6	C	O	C	–
7	C	C	–	–
8	C	C	O	O
9	C	O	C	–
10	C	C	C	C
11	C	C	C	C
12	C	O	C	–
13	C	C	–	–
14	C	C	–	–
15	C	C	–	–
16	C	C	C	–
17	C	–	–	–
18	C	C	O	–
19	C	–	–	–
20	C	–	C	–
21	C	C	C	–
22	C	C	O	–
23	C	C	C	–
24	–	C	C	–
25	C		–	–

C = Chimney; O = Other systems.

Table 9. Water elements.

Water element	Presence	Number of houses	Percentage (%)
Cistern	Yes	5	20
	No	20	80
Well	Yes	8	32
	No	17	68
	Condition	Number of wells	
	Covered	3	37.50
	Not used	2	25.00
	Water is bucketed	3	37.50

found that the fresh water and waste water systems were successfully applied.

CONCLUSIONS AND RECOMMENDATIONS

This study investigated the building-sanitary equipment in the traditional Trabzon urban houses that have completed their evolution and that have original characteristics. The study aimed as follows:

(1) To make the reader have an insight into the building-sanitary equipment in the traditional houses,
(2) To reach some conclusions and identify some applications that can be taken as the bases for today's works and applications. The study investigated the notions

of water disposal, heating and chimney systems and drainage systems under the title of building-sanitary equipment.

(3) When the notion of water disposal was investigated, it was found that although there are some successful roof applications in the traditional houses, rain gutters and downspouts are inadequate in disposing the rainwater and snow water that collect on the roof surfaces.

(4) When the heating and chimney systems were investigated, it was found that priority was given to the heating of the kitchen and that the heating of other spaces was neglected. On the other hand, although the chimney system applications are usually correct, the number of chimneys is not enough for the houses.

(5) As for the drainage systems, it was found that the traditional fresh water supply systems have been deactivated today, that all the fresh water needs are met by the city water supply network and that the waste water of the houses is disposed of by direct connections to the city sewer system.

(6) Despite the developments and changes in the constructional domain, most of the best building-sanitary equipment in the traditional houses have still been the same and superior. In this case, we must definitely stick to the traditional. If we are in unnecessary attempts to try again and again, we shall deprive ourselves of a sturdy basis. Consequently, the need for the investigation of the samples that belong to the past but that give us information about the building-sanitary equipment is apparent. As a result of such an investigation of such samples, the findings must be presented clearly.

It is necessary that the relationships between the sanitation needs and other needs (visual needs, security needs, hygiene needs, comfort needs, etc.) of the houses be identified and investigated. These needs of the houses must be dealt with not individually but altogether within the way of life of the society. This can be achieved only when the needs are dealt with altogether.

The increase in the number of such studies is important in that it gives us an opportunity to investigate and interpret what we should make use of.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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APPENDIX

Questionnaire

Address : ……………………………………………………………………
Sample no : …………
Owner : ……………………………
Age of building : ………

A. Information on the structural characteristics of the building

1. Type of residence:
   - Detached house ☐
   - Semi-detached house ☐
   - Terrace house ☐

2. Outer wall construction:
   - Cell infill ☐
   - Triangular infill ☐
   - Plasterboard ☐
   - Timber-frame ☐
   - Ruble infill ☐
   - Firebrick infill ☐
   - Briquette infill ☐
   - Other …………………………

3. Inner wall construction:
   - Plasterboard ☐
   - Timber-frame ☐
   - Ruble infill ☐
   - Firebrick infill ☐
   - Briquette infill ☐
   - Other: …………….

4. Plaster on the outer surface:
   - No plaster ☐
   - Plaster on the filling material ☐
   - Plaster on all surfaces ☐

5. Paint on the outer surface:
   - No paint ☐
   - Paint on the filling material ☐
   - Paint on all surfaces ☐

6. Direction of the entrance façade: …………………

7. Flooring material:
   - Ground floor (……………)
   - 1st floor (……………)
   - 2nd floor (……………)
   - 3rd floor (……………)

B. Kitchen

1. Any repair work, addition or change carried out in the kitchen.
   - None ☐
   - Repair work ☐
   - Change (pipe, cistern, etc) ☐
   - Replacement ☐
   - Enlargement ☐

2. Date of, and reason(s) for, change: (…………………………………)

3. Kitchen is:
   - Inside the house ☐
   - Outside the house ☐

4. Cooking equipment Stove
- Spirit cooker ☐
- Kerosene cooker ☐
- Bottled gas cooker ☐
- Electric cooker ☐
- Electric oven ☐
- Combination oven ☐

(Stove ☐)

5. Kitchen sink is:
- High from the floor ☐
- On the floor ☐

6. Height of the kitchen sink from the floor: ……… cm.

7. Fresh water pipe system:
- Lead pipe ☐
- Copper pipe ☐
- PVC pipe ☐
- Galvanized pipe ☐

8. Fresh water pipe diameter: ……… cm.

9. Waste pipe system:
- Cement pipe ☐
- Cast iron pipe ☐
- PVC pipe ☐

10. Waste pipe diameter: ……… cm.

11. Faucets:
- ground-key faucet ☐
- Screw faucet ☐
- Slide faucet ☐

12. Kitchen material:
- Wall ☐
- Floor covering ☐
- Ceiling ☐

13. Complaints from, and remarks for, the old (and new if any) kitchen equipment: …………

C. Bathroom

1. Any repair work, change or addition made in the bathroom.
- None ☐
- Repair work ☐
- Equipment (pipe, cistern, etc.) ☐
- Change ☐
- Replacement ☐
- Enlargement ☐

2. Date of, and reason(s) for, change: (………………………………)

3. Number of bathrooms in the house: ………

4. Number of rooms with private washing spaces: ………

5. Water heating system in the bathroom:
- Water heater ☐
- Thermosiphon ☐
- None ☐

6. Fresh water pipe system:
- Lead pipe ☐

Copper pipe ☐
PVC pipe ☐
Galvanized pipe ☐

7. Fresh water pipe diameter: ……… cm.

8. Waste pipe system: Cement pipe ☐
Cast iron pipe ☐
PVC pipe ☐

9. Waste pipe diameter: ……… cm.

10. Washing equipment in the bathroom: Marble basin ☐
Shower tray ☐
Bathtub ☐
None ☐

11. Bath trap: Yes ☐
No ☐

12. Faucets: ground-key faucet ☐
Screw faucet ☐
Slide faucet ☐

13. Bathroom material: Wall ☐
Floor covering ☐
Ceiling ☐

14. Complaints from, and remarks for, the old (and new, if any) bathroom condition: ………

D. Toilet

1. Any repair work, change or addition made in the toilet.
None ☐
Repair work ☐
Equipment (pipe, cistern, etc.) ☐
Change ☐
Replacement ☐
Enlargement ☐

2. Date of, and reason(s) for, the change: (…………………………………)

3. Direction of the toilet: ………………

4. Number of toilets in the house: ………

5. Toilet is: Inside the house ☐
Outside the house ☐

6. Fresh water pipe system: Lead pipe ☐
Copper pipe ☐
PVC pipe ☐
Galvanized pipe ☐

7. Fresh water pipe diameter: ……… cm.

8. Waste pipe system: Cement pipe ☐

Cast iron pipe ☐
PVC pipe ☐

9. Waste pipe diameter: ……… cm.

11. Cistern Yes ☐
No ☐

11. Faucets: ground-key faucet ☐
Screw faucet ☐
Slide faucet ☐

12. Measures taken for malodor in the toilets with no cisterns: No measures ☐
Use of stopples ☐
Use of metal lids ☐

13. Toilet material: Wall ☐
Floor covering ☐
Ceiling ☐

14. Complaints from, and remarks for, the old (and new, if any) toilet condition: ………