



Perceptions of Consumers, Housing Supervisors, and Design Engineers of Public Housing on the Plumbing System

Persepsi Konsumen, Pengawas, dan Perencana Perumahan Rakyat Terhadap Sistem Plumbing

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ABSTRAK

Sistem perpipaan (plumbing) adalah sistem perpipaan pada sebuah gedung atau rumah yang terdiri dari air bersih, air limbah, dan air hujan. Mengingat pentingnya hal ini, pengetahuan tentang sistem plumbing perlu dimiliki oleh setiap stakeholder. Tujuan dari penelitian ini adalah untuk mengetahui persepsi konsumen, pengawas, dan pengetahuan perencana terhadap sistem plumbing pada perumahan rakyat dan juga untuk mengetahui kondisi sistem plumbing yang terpasang pada perumahan tersebut. Metode penelitian yang digunakan dalam penelitian ini adalah deskriptif kualitatif dengan pengumpulan data primer melalui survei terhadap pengembang perumahan rakyat di Solo, Semarang, Makassar, dan Palembang. Hasil penelitian menunjukkan bahwa pengetahuan konsumen tentang sistem plumbing pada bangunan rumah kurang baik. Sementara itu, pengetahuan perencana dan pengawas rumah tentang sistem perpipaan sudah baik. Perencana dan pengawas bangunan tahu bahwa ada peraturan dan standar mengenai sistem dan peralatan plumbing. Namun, standar nasional SNI 8153:2015 tentang sistem plumbing belum sepenuhnya diterapkan di perumahan. Penyediaan rumah dengan harga terjangkau berdampak pada penggunaan peralatan dan sistem plumbing. Spesifikasi peralatan yang digunakan belum dapat secara optimal memenuhi standar yang ada, karena harus mempertimbangkan biaya produksi pembangunan rumah dan harga jual rumah tersebut.

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ABSTRACT

The plumbing system is a piping system in a building or house consisting of clean water, wastewater, and rainwater. Given the importance of this, knowledge of the plumbing system needs to be owned by every stakeholder. The purpose of this study was to determine the perceptions of consumers, supervisors, and design engineers knowledge of the plumbing system in public housing and also to determine the condition of the plumbing system installed in the housing. The research method used in this research was descriptive qualitative, with primary data collection through surveys of the public housing developers in Solo and Semarang, Makassar, and Palembang. The results show that the consumer's knowledge of the plumbing system in house buildings was not good. Meanwhile, the knowledge of design engineers and supervisors regarding the plumbing system was good; design engineers and supervisors knew that there are rules and standards regarding plumbing systems and equipment. However, the national standard SNI 8153:2015 regarding the plumbing system had not been fully applied in housing. The provision of housing at affordable prices has an impact on the use of plumbing equipment and systems. The specifications of the equipment used cannot optimally meet existing standards because they must consider the production costs of house construction and the selling price of the house.

1. INTRODUCTION

1.1 Background

Drainage is one of the important city assets in maintaining the comfort and health of its residents. Good drainage designing, starts from small residential to industrial and then to the main government pipeline and ends at the large discharge point. As part of the drainage system, water management at the residential level as one of the upstream drainage systems should be developed and maintained properly. Improper designing of the drainage system in housing can result in flooding, water will overflow onto the road and have an impact on the surrounding community. Water that overflows during a flood is not only clean water from rainwater but water that is mixed with other chemical elements that can interfere with people's health and comfort (Saputra & Fu, 2021).

One of the water management in housing is using a plumbing system. The plumbing system is an inseparable part of the construction process because it is one of the factors that determine the comfort level of a building (Ayuningtyas *et al.*, 2022). Plumbing is defined as everything related to the piping for clean water and sewage lines connected to the municipal sewage system, including the installation of pipes and equipment inside or outside buildings to provide the desired cleanliness. Plumbing is also defined as an installation designed for water management with sufficient pressure at certain points without polluting other critical areas (Setiawan & Marbun, 2021). Specifically, the definition of plumbing is a piping system in buildings that includes the supply and use of quality clean water, drinking water supply systems, and wastewater distribution. While the plumbing system is a drinking water supply system, wastewater distribution, and drainage, including all connections, tools, and equipment installed in parcels and buildings (Sudarmadji *et al.*, 2012).

Plumbing systems are applied in various buildings, such as hotels (Rinka, 2014), hospitals (Rahayu *et al.*, 2020), universities (Afrhian *et al.*, 2020), office and government buildings (Mareta & Hidayat, 2020), including housing (Saputra & Fu, 2021). In residential buildings, the plumbing system is essential for the comfort of the occupants. This system will determine the distribution of clean water into the house, as well as distributing dirty water or household wastewater out of the house, including the distribution of rainwater so that the house can function properly. If the plumbing system is not planned properly, the water supply system in the building will be problematic and become an obstacle for the occupants. This also includes repairs, which will require a lot of time and money when repairing and renovating the plumbing system because it is already installed in the building.

Every building must meet reliability requirements, which include safety, health, comfort, and convenience (Indriana, 2019). One of the guidelines and standards that regulate the plumbing system is the Indonesian National Standard (SNI) 8153:2015 concerning the Plumbing System in Buildings, which refers to the 2012 Uniform Plumbing Code (UPC) and the 2012 UPC Study Guide. This standard is an amalgamation and revision of SNI 03-6481-2000 on plumbing

systems and SNI 03-7065-2005 on procedures for designing plumbing systems. This standard is also used as a reference in designing plumbing systems in buildings. SNI 8153: 2015 contains: specifications of plumbing and its equipment; designing, installation, modification, repair, replacement, addition, and maintenance of plumbing systems; and applications for new plumbing systems and repaired plumbing systems (Badan Standardisasi Nasional, 2015). This standard provides convenience and quality assurance for design engineers, users, and managers of plumbing systems in buildings. Plumbing system standards can be used as a reference for design engineers, implementers, and quality control in the installation of plumbing systems in buildings.

Public housing is a collection of houses as part of a settlement, both located in urban and rural areas, and equipped with various infrastructure, facilities and public utilities to meet the criteria for livable housing (Anita, 2021). Public housing is a type of house that anyone can buy or live in, of course, with the rules and regulations that apply. In contrast to private housing, which is usually reserved for certain circles. Public housing is the most used type of house in Indonesia. The house functions as a place to live and it is a basic human need, so the house should be built according to the main human needs from the aspects of safety, comfort, functionality, and sustainability. The plumbing system is part of the home system as a supporting aspect of functionality and sustainability. This aspect is often overlooked by developers or residents, especially in housing, where price is the main factor.

Stakeholder perceptions of the plumbing system need to be known to explore problems installing the plumbing system in housing. Etymologically, perception comes from the Latin perception which means to receive or take. Perception is a process by which various stimuli are selected, organized, and interpreted into meaningful information (Wenas *et al.*, 2015). Perception is the way in which consumers give meaning to a series of stimuli and this is a process of cognition. When consumers interpret an advertisement they see, a process of cognition occurs in the minds of consumers. Perception is not only important in the information processing stage but also plays a role in post-consumption of products, namely when consumers evaluate purchasing decisions, whether consumers are satisfied or otherwise, this assessment is also inseparable from their perceptions. Perception is also a process that arises as a result of a sensation, which is the activity of feeling or causing the state of an emotion (Huriartanto *et al.*, 2015). In connection with this research, perception is a response or activity felt by consumers, supervisors, and design engineers on the application of a plumbing system in housing.

The development of plumbing systems in livable housing in addition to aspects of quality and good management, it is necessary to know the perception of residents on the application of the plumbing system so that management is more optimal and in accordance with the needs of residents. Perception is observations about objects, events or relationships obtained by inferring information and interpreting messages (Mukti & Rahardjo, 2016). There are aspects in perception are considered relevant to human

cognition, namely sensory recording, pattern recognition, and attention, in addition to the need for the participation of residents in the management of the plumbing system. National housing is a type of housing that is mostly built in Indonesia to meet the housing needs of the lower middle class. This type of housing usually prioritizes the aspect of affordability and is less concerned with sustainability aspects such as water management.

1.2 Research Objectives

The aim of this study was to determine the perceptions of consumers, supervisors, and design engineers knowledge of the plumbing system in public housing. This study also aimed to determine the condition of the plumbing system installed in the housing. The condition of plumbing equipment depends on its quality and service life, so this research focused on the condition of the plumbing system and products that had been used for a maximum of two years after occupying the house.

2. METHOD

This research used a descriptive qualitative method with primary data collection through direct surveys of respondents. The descriptive qualitative method is a research procedure that produces descriptive data in the form of written or spoken words from people and observable behavior. The population of national housing or public housing in Indonesia is huge and is not known with certainty so in this study, the sample of respondents was taken by purposive random sampling method on consumers, supervisors, and developers of public housing in Solo and Semarang (Central Java), Makassar (South Sulawesi), and Palembang (South Sumatra) with the number of respondents are shown in Table 1. The sampling technique with purposive sampling is taking samples selected based on certain criteria set by the researcher (Widyantari et al., 2018 and Shahriari et al., 2020). The selection of respondents was based on reasons that housing and economic growth in the area were few of the highest in Indonesia. In this study, researchers also considered the willingness of respondents to participate as research objects, the availability of funds, and human resources. Housing criteria were limited to a maximum building area of 45 m². Respondents were grouped into three categories, namely consumers, supervisors, and design engineers. Public housing consumers were residents of public housing who had lived in the house for at least one year. Supervisors were employees of the public housing provider companies in charge of supervising housing development. Design engineers were providers of public housing, including

developers. Primary data regarding plumbing perceptions was obtained by structured interviews with all respondents regarding their knowledge about planning and application of plumbing systems and the equipment used. The object that was discussed in this research was the plumbing installation system, which included clean water inlet pipes, dirty water outlet pipes, faucets, toilets, and septic tanks. The checks on plumbing equipment were directly carried out by a team of housing researchers and developers and the results were confirmed by consumers. The selection of the plumbing tool was based on the dominance of the most widely used plumbing tool in public housing.

The observation technique is an activity that focuses attention on an object by using all senses. Things observed in this study could not be separated from the focus of the research, namely the condition of consumers, supervisors, and public housing design engineers on the application of the plumbing system. Data were collected through observation techniques using field notes as the main tools. Afterward, the data was analyzed using descriptive qualitative methods.

3. RESULTS AND DISCUSSION

3.1 Consumer Perception of the Plumbing System

The damage that the author uses is that the plumbing equipment cannot be used properly, its function is reduced, it does not meet specifications or does not comply with application procedures. Based on Table 2, the average percentage of damage to plumbing equipment is 12.7%, dominated by damage to clean water pipes or inlet pipes. The damage that occurred included cracked pipes, broken pipes, leaking pipes, wrong pipe specifications, and wrong installation. Clean water pipes play a role in channeling clean water from water sources into homes that are used for bathing, washing, and even drinking water if the water quality is able to meet the requirements for ready-to-drink water. The clean water transmission system to housing is a piping system from water sources to residential buildings by taking into account the type, diameter, and pipelines (Nelwan et al., 2013). One of the determinants of clean water quality is the availability of quality and standardized piping. The parameters of smell, color, and taste of water can change because of contact between water and decaying organisms along with infiltrated sludge particles into water pipes. This will be more complex if the pipe is damaged or leaks so that organisms can easily enter the water channel. Leaks in the plumbing system and if the water supply is off, the pressure will drop and the contaminated water will enter the pipes through the gaps in the pipe walls so the water will be contaminated (Anes et al., 2017).

Table 1. Number of research respondents.

Location	Consumer	Supervisor	Planner
Solo and Semarang	20	1	1
Makassar	20	1	1
Palembang	20	1	1
Total	60	3	3

The following product that suffered the most damage was the faucet product, with damage including broken faucet handles, not being able to close the flow completely and the faucet rusting. Water faucets are the most common products and almost 99% are found in human life and are related to water (Hapsari & Damayantie, 2018). The faucet functions to drain water from the pipe to the user or consumer (Shaputra et al., 2019). A broken faucet causes water to continue to drip even though the faucet is closed, so that the water continues to flow even if only a little, resulting in water loss (Satya Graha et al., 2017). Other plumbing equipment that was damaged but less frequently were dirty water pipes, septic tanks, and toilets. These three products are sewers for sanitation of dirty water and waste.

The results of the interviews show that every existing housing project uses a third-party water provider, either from PDAM (Regional Drinking Water Company) or the private sector. Based on the results of direct field tests it is known that the average pH of the water is 7.28. Water consumed by humans must be clear and clean with a pH level of ordinary drinking water ranging from 7-7.4, this level is the normal level of drinking water consumed by humans (Rachmat et al., 2022). The choice of using a drinking

water service provider is carried out to keep the groundwater level unchanged.

Based on the data in Table 3, the availability of the amount of water was considered sufficient (90%). The preference for its use was for daily needs, which were related to two rooms, namely, the bathroom and kitchen. Referring to this, the most widely used plumbing system was the inlet and outlet channels to/from the bathroom and kitchen area.

Based on interviews with respondents, most of the respondents could not choose which plumbing equipment to install because everything had been determined by the housing design engineers or developer. In this case, the consumer could only use and maintain the available plumbing equipment. According to Figure 1 and Figure 2, most of the respondents also did not know good and quality plumbing systems and equipment. In this market niche, affordable price is still the main variable in choosing a house, so other important aspects such as the plumbing system are less of a consideration. Poor knowledge of plumbing systems and equipment results in damage to equipment and plumbing systems in national housing, even though they have not been occupied for long.

Table 2. Damage to plumbing equipment.

Location	House type	Number of Respondents	Total plumbing equipment damage				
			Inlet pipe	Outlet pipe	Faucet	Toilet	Septic tank
Solo and Semarang	27/60, 36/96	20	11	2	2	1	-
Makassar	36/98, 36/119	20	3	-	2	-	-
Palembang	36/104,45/136	20	9	3	3	-	2
Total		60	23	5	7	1	2
Percentage		-	38.3%	8.3%	11.7%	1.7%	3.3%
Average					12.7%		

Table 3. Water usage preference.

Parameter	Description	Value
Water quantity	Most of the respondents stated that the water used for daily needs was considered adequate	54 respondents stated adequate water availability (90%)
Cost	The value of payments to water supply companies, each housing might have a different payment scheme	The cost of water needs between IDR 30,000 to IDR 300,000
Water use	a. Used for daily needs, among others: kitchen, bath, and toilet (non-consumption)	59 respondents (98.3%)
	b. Used to support businesses in the form of restaurants, and salons.	10 respondents (16.7%)

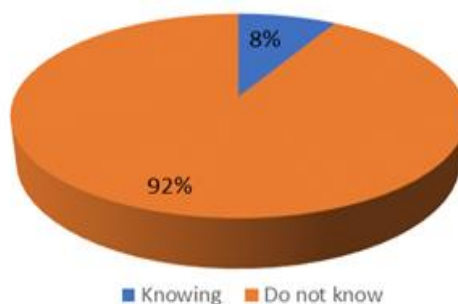


Figure 1. Consumer knowledge of plumbing systems



Figure 2. Knowledge of building supervisors and planners about plumbing systems.

3.2 Perceptions of Design Engineers and Supervisors of the Plumbing System

Design engineers already have housing designing procedures for housing construction work. According to Figure 2, design engineers and supervisors are also knowledgeable about the rules of a good plumbing system. Although the implementation of standards provides many benefits (Susanto et al., 2016 and Susanto et al., 2018), knowledge of SNI 8153:2015 is still minimal, based on the results of interviews it is known that this is because SNI 8153:2015 was not specifically aimed at the public housing sector. Furthermore, other SNIs regarding plumbing product specifications were not widely known. SNI 8153:2015 also had never been socialized to the developer, and the supervisors/design engineers already had technical specifications used for simple housing.

State-owned enterprises (BUMN) are required to be independent and profitable. On the other hand, they are required to provide housing units at affordable prices but must also meet safety and security aspects. This is recognized as having an impact on the use of plumbing equipment. The specifications of the equipment used could not optimally meet existing standards, because they had to consider project costs and unit selling prices. Based on interviews, the design engineers had optimized the layout of the plumbing tools used, such as the position of the toilet and floor drain was considered for efficient use of pipes, placement of clean water pipelines did not interfere with construction/buildings, and the positions of the water meter, septic tank, etc considered the location of the lot.

Supervision of construction work at each housing location was carried out by each local regional office with the same procedures issued by the head office with responsibility for all construction work carried out by the tender-winning contractors. The specification document in the contract became the basis for the supervision process. Some of the obstacles faced in the supervision process are specifications contained in the contract might provide different interpretation opportunities, for example, the size and quality of materials that were considered equal or equivalent to the brand quality of a plumbing tool. There were no required documents to prove the level of equivalence. Furthermore, the scope of supervision was not proportional to the number of supervisory personnel, and environmental change factors, such as changes in soil structure and weather, resulted in the need for adjustments in project implementation.

Meanwhile, based on the results of supervision, the most problem found during the installation of the plumbing system was the installation error in the pipe connection either because it was often loose or due to elevation errors during installation, which might cause flow resistance that resulted in leakage. Next, related to the neatness or finishing of the installation of plumbing tools, several problems that did not go according to the plan because the slope of the pipe was too small so that the water could not flow properly. Furthermore, broken pipes (especially exhaust pipes) due to vertical loads, which was caused by the depth of pipe installation was not deep enough, and the owners of simple houses (subsidized price) always renovate by adding plumbing equipment in the house, this was to meet the distribution of water in the house.

In the clean water supply system, plumbing equipment must be supplied with water flow of sufficient quality and pressure so that they can work properly in accordance with the required water usage standards. The water distribution system should be planned so that with minimal water capacity and pressure, the plumbing equipment works properly. In conditions of low water pressure, it will cause difficulties in using water, the plumbing device does not function because it cannot drain water, while at excessive pressure it can cause pain when exposed to jets of water and accelerate damage to plumbing equipment (Sudarmadji et al., 2012).

The application of a good and correct plumbing system is beneficial for saving the use of water resources (Rinka, 2014) and maintain environmental conditions and prevent flooding (Saputra & Fu, 2021). Comparison of water usage in conventional and non-conventional plumbing equipment shows that water use using non-conventional plumbing tools is smaller than the standard conventional plumbing equipment where the percentage of savings reaches 40.64% and the effect on the resulting wastewater discharge is reduced (Rahayu et al., 2020). This condition also affects the cost of saving water, electricity costs for pumping and the cost of domestic wastewater treatment. A good plumbing system is also useful for helping fire safety systems in buildings and housing (Mareta & Hidayat, 2020)..

4. CONCLUSION

Consumers need better knowledge of the plumbing system in public housing. In public housing, most respondents can only accept finished houses if they are able to ask for a special specification, including the plumbing

system and equipment used. The possibility of damage to plumbing equipment is almost certain in all housing projects, with the most damage occurring in pipes and pipe connections. The quality of the plumbing tools is an important factor that must be considered in addition to the accuracy of installation and usage patterns. The knowledge perception of design engineers and house building supervisors regarding the plumbing system is good. Design engineers, and supervisors are aware of the rules and standards regarding plumbing systems and equipment. Housing designing is carried out centrally based on the company's technical specifications, the existence of SNI 8153:2015 has not been utilized for housing because of its scope.

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