



Ethiopian Institute of Architecture, Building construction and City Development
School of graduate studies

Optimization of underutilized public sanitation unit, the case of Wurerber, South-East Ethiopia

By:

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A thesis submitted to the graduate studies of Addis Ababa University in partial
fulfillment of the requirement for the degree of Master of Science in
Architectural Engineering

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Declaration

I, the undersigned, declare that this thesis is my own and original work and has not been presented for a degree in any other university, and that all sources of material used for the thesis have been duly acknowledged, following the scientific guidelines of the Institute.

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This thesis is submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) and to the School of Graduate Studies of Addis Ababa University in fulfillment of all requirements for the degree of Master of Science in Architectural Engineering.

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Abstract

The purpose of this thesis is to investigate and find the architectural values, which use for optimization of Public Sanitation Unit (PSU). The PSU project, in this thesis, was designed and constructed in Wurerber Kebele, in south-east Ethiopia. The unit has been serving the community since 2017. The unit has mainly two functions, which are showering and laundry. The general aim of the PSU project was an attempt to construct a water and sanitation infrastructure unit, which can be used as a focal point and a catalyst for activating rural-urban space. Based on an onsite observation, the constructed shower and laundry unit utilization rate, performance, and functionality have low outcomes. This was the core problem of this thesis, which initiates the optimization research on the unit. Therefore, this thesis tries to investigate and find the existing situations and the contributing factors for the reduced utilization rate of the PSU. To obtain an optimized architectural PSU design mixed descriptive type of research method has used in the research. The first part of the research is, defining underutilization and factors affecting PSU, evaluating the existing rate of utilization of the sanitation unit, and finding the opportunities for improvements. In the second part an observational approach for collecting primary data through onsite field observation, questionnaire survey, and interviews are conducted. Besides, Secondary data were collected from published and unpublished works of literature; meanwhile, the research tries to claim a valid statement from triangulating these mixed methods. The third part considers case studies from different sanitation practices to explore publicly accepted sanitation unit trends. The fourth part has the result and finding from the analysis that articulates the problem, which is related to the topological and geometrical aspects of the unit. The functional, technical, behavioral and managerial values are found as the pillars to affect the underutilization of PSU in Wurerber Kebele. Finally, the research finds and concludes an architectural intervention based on the four values is certain to obtain an optimal architectural design. Because underrating these values the PSU could bring adverse impact on the underutilization of the unit. Optimization of these values will increase the usage and at the same time the public acceptance of the PSU.

Keywords: Public sanitation unit (PSU), Optimization, Values, Rate, Underutilization,

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Acronyms and abbreviations

AAU – Addis Ababa University

EiABC – Ethiopian Institute of Architecture and Building Construction

GTP II – Growth and Transformation Plan II of Ethiopia

PSU – Public Sanitation Unit

USAID - United States Agency for International Development

UN-Habitat - United Nations Human Settlements Program

GPM – Gallons per minute

ABR - Anaerobic Baffled Reactor

Km - Kilo Meter

Chapter one: Introduction

By 2030, urban populations worldwide are expected to grow by 1.4 billion people, with city and town dwellers accounting for 60% of the world's population (USAID, 2013). By 2050, this figure is expected to reach 2.6 billion (ibid.). While the pace and pattern of urban growth and urbanization vary, the vast majority of growth will take place in developing countries, with migration and urban growth leading a shift in the locus of global poverty that has been described as the 'urbanization of poverty' (UN-Habitat, 2016).

Ethiopian GTP II has a goal to raise urbanization by 25% by the year 2020. This is an increase of 6% in the next 5 years. This will create around 4500 new towns or urban centers (National Planning Commission, 2016). This aims in the reduction of migration to urban areas reduce diverse problems like urban poverty, over exhaustion of infrastructures poor living conditions, etc. Continuing urbanization or migration from rural to urban areas will expand the number of megacities, and it concedes that environmental deterioration, inadequate housing, traffic congestion, slums, crime, homelessness and so forth often plague megacities. (Makinde, 2012)

Wurerber is a village that is located in the southern nation's nationalities and peoples of Ethiopia. In Gurage zone, Cheha Woreda. The village has estimated 2561 total population. (Wurerber health center 2019) There are some investments like agriculture and a couple of factories, which benefits temporary and permanent residents as a work opportunity provided. An experiment on the provision of a water point serving a sanitation unit was designed and constructed as an attraction point in which the Kebele urbanization and to be a focal point, by EiABC (Ethiopian institute of Architecture and building construction), Addis Ababa University & Bauhaus University, Weimar. The aim of this infrastructure unit was to catalyze the rural urbanization of the village. The project tries to attempt to make initiation on the society on rural urbanization and to attract the villagers by providing an integrated infrastructure unit; however, the expected outcome is not very much satisfactory. (Own preliminary survey)

For the construction of the project, students from both universities, EiABC & Bauhaus University were participated. This Ethio-German team tried to design the possible scenario to use the available construction materials and some improved techniques of

construction. And fortunately the researcher was a team member for the construction of the project from EiABC. Though when the researcher try to see the existing features of the sanitation unit by physically being onsite, the expected outcome as an attractive and a focal point was not that much satisfactory, since the usage frequency is very low as observed onsite. (Own pilot survey)

Users decide whether they will use the given space or not. Of course, space created by an architect constitutes a specific offer as well as a proposition. It also possesses specific solutions. At the end of the day, however, the user makes the final choice. His or her approval constitutes a confirmation of a well-prepared functional and utility program and a correct recognition of user groups together with their needs. That is why the designers should be concerned not only about how the infrastructures (seen together as a system, not individually) evolve, but also about the way they interact. (J. Charytonowicz, C. Falcão 2018)

This thesis have tried to investigate the contributing factors for underutilization of the public sanitation unit. For this case, this thesis used a descriptive research design, since the aim of this specific research design is to find the factors for studying the situation. Both the qualitative and quantitative data have been collected and analyzed for the comprehensive understanding of the unit. The theoretical framework is designed for restructuring the possible ways for the optimization of the sanitation unit from the literature review. Even there is no defined was for optimization of a sanitation unit, this thesis aims at producing one which could be used for related problems. After studying and analyzing the factors or values for the optimization of the sanitation unit, a conclusion and recommendation have been made and design guideline have been set. Then a possible prototype design scheme is proposed.

1.1. Problem statement

Public sanitation unit is designed and constructed in Wurerber Kebele, which have a shower and laundry function. The general aim of the project was an attempt to construct a public sanitation water point expected to be a focal point and a catalyst for activating urbanization of the area. The specific aim of the project was the implementation of an improved sanitary concept for personal hygiene combined with an attracting point, which invites to rest and to gather. (Unpublished document) Based on an onsite observation & preliminary pilot survey on the utilization rate and performance of the built sanitation unit, it is underutilized and the expected aim as a focal point and a catalyst for activating the rapid urbanization of the area is witnessed unsatisfactory by the researcher. Therefore, this thesis investigates the existing situations and the contributing factors for the reduced utilization rate of the sanitation unit.

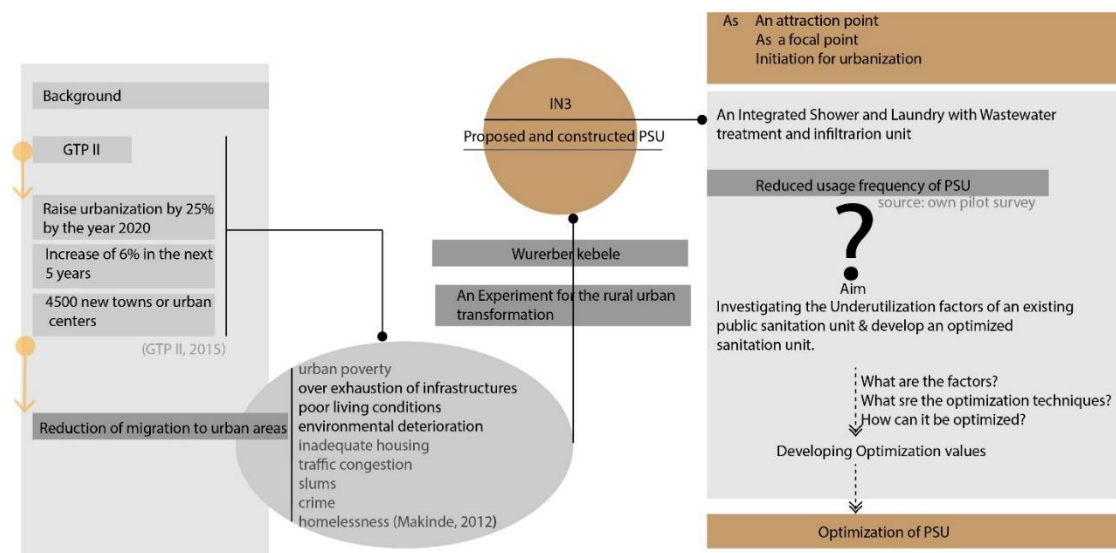


Figure 1 Problem statement chart

1.2. Objective

A) General objective

- to investigate the main factors for underutilization of an existing public sanitation unit & develop an optimized sanitation unit.

B) Specific objective

- to study the means of optimization of a sanitation unit.
- to identify the mismatch of the unit setup and the underutilization of the sanitation unit.
- to develop an acceptable and usable public sanitation unit.

1.3. Research questions

In order to meet the general objective of the research, which is investigating the main factors for the underutilization of an existing public sanitation unit and to develop optimized, sanitation unit, for this general objective, the specific research questions have been set:

1. What are the means for optimization of a sanitation unit?
2. What are the factors for the mismatch of the unit setup and the underutilization of the sanitation unit?
3. Are there any possibilities of proposing a general design framework for the design of public sanitation units, which gives an optimal rate of utilization?

1.4. Scope

The investigation is done from down to desk time interval focusing on factors for underutilization of existing public sanitation unit which was intended to give an integrated shower and laundry service constructed to be a seed and germinated as an attraction point for the future development led and constructed by IN3 project in Wurerber, Cheha Woreda, Gurage Zone.

1.5. Limitation

One of the limitation of the study was a time constraint, because the period provided for conducting research & proposal design prototype is short & both were time consuming. Access to the literatures in the case of optimization of underused sanitation unit and in general cases of optimization techniques was one of the limitation of this research. The other limitation of this thesis was that the evaluation the outcome practically was not applicable because of the financial shortage problems, so the researcher could not test the prototype and see practically its outcomes.

1.6. Significance

In this research, the researcher have tried to show the factors for underutilization of the sanitation unit constructed in Wurerber Kebele, and then recommend the possible ways of optimizing such kind of sanitation units. In addition, to propose a prototype design by taking the better way of design approach by advice rather than command for configuration of building spaces and details, which could be adoptable for same kind of buildings in the emerging cities of Ethiopia. Generally, the study will be significant in terms of:

- Providing some strategies for planners, administrators, and policy and decision makers with respect to provision of sanitation units.
- It will equally create awareness on the public acceptance regarding the design and implementation of sanitation units for researchers and academicians.
- It will create a tool in terms of optimization of underused sanitation units for designers and architects.
- It will also help the public to use a sanitation unit in low cost and improved facility.

1.7. Organization of the paper

This thesis is composed of six chapters. First chapter deals with Introduction to the research here Background Problem statement, Objective of the research, Research question, Scope and limitation and the like are the subparts of the chapter. On the second chapter Theoretical framework for the study have been addressed, theories like

optimization, and optimization techniques have tried to be addressed. On the third chapter, description of the infrastructure unit have been discussed, here; Aim and goal of the project, Project location, and Current infrastructure service practice, Comparing the proposed unit with the current unit, Stakeholders, Cultural framework considerations are the main parts of the discussion. On the fourth chapter, the research conduction method have been discussed like; Inception discourse, Site visit and observation, Deep interviews & Questionnaire are the main discussion areas. On the fifth chapter results, from the data collection analyzed and results & discussion presented. On the sixth chapter conclusion and recommendation is presented and with public sanitation unit design guideline and a possible alternative design is proposed.

1.8. Conceptual frame work/research outline

The conceptual framework for this thesis is presented as follows; it is designed to have six chapters. The conceptual framework navigates the whole research activity. This framework also serves as a “map” or “rudder” that have guided me towards realizing the objectives or intent of the study. Therefore, the thesis have followed this framework as a guideline for moving from one benchmark to the next.

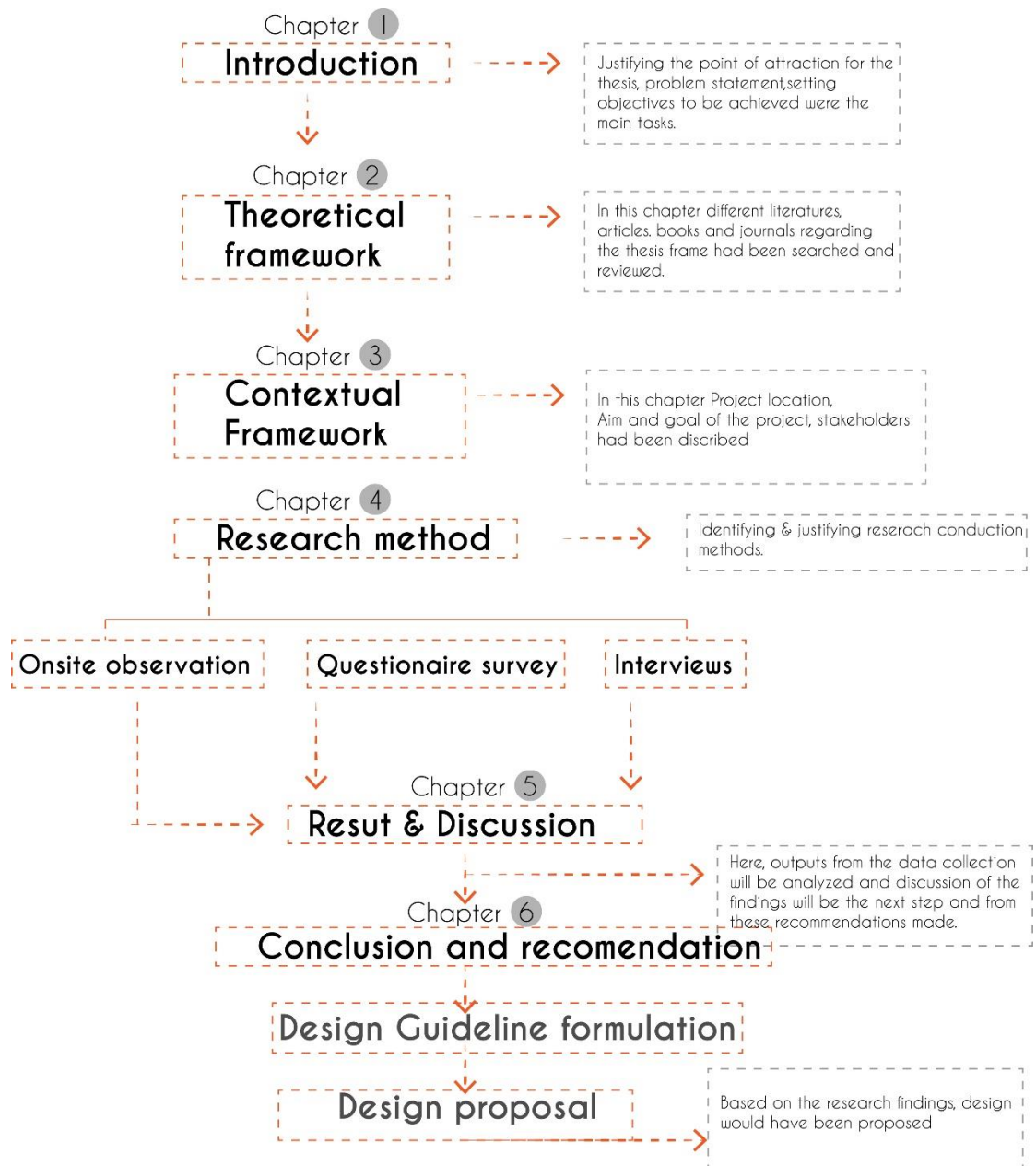


Figure 2 Research outline

Chapter Two: Literature review

2.1. Definition of terminologies

Since one of the limitation of this research is the availability of limited literatures regarding optimization and techniques for optimization, the research try to understand the terminologies from their basic dictionary definitions accordingly.

Underused:

According to Merriam Webster dictionary, it is an adjective and spelled as:

Un·der·used | \ ,ən-dər-'yüzd \

Definition of underused: Not fully used: having more potential than is currently being realized or utilized

Optimization:

Definition of *optimization*

1. Meriam Webster dictionary Noun op·ti·mi·za·tion | \ ,äp-tə-mə-'zā-shən \

: An act, process, or methodology of making something (such as a design, system, or decision) as fully perfect, functional, or effective as possible.

2. Dictionary

- The act of rendering optimal
- In an optimization problem, we seek values of the variables that lead to an optimal value of the function that is to be optimized.

Optimization of values

Since optimization seeks values for the optimal level of utilization, the research had defined the values of the built architectural unit. The design values of architecture are aesthetic, social, environmental, traditional, gender-based, economic, novel, mathematical, and scientific — follow that (Ukabi, 2015). Based on Lera (1980), Ukabi tabulated the values and intentions that historically shaped architectural design.

Table 1 Architectural design values and respective intentions (Ukabi, 2015)

Design Value	Intentions
<i>Aesthetic</i>	1.Artistic aspects and self-expression
	2.Spirit of the time
	3.Structural, functional, and material honesty
	4.Simplicity and minimalism
	5.Natural and organic
	6.Classical, traditional, and vernacular
	7.Regionalism
<i>Social</i>	1.Social change
	2.Consultation and participation
	3.Crime prevention
	4.The “Third world”
<i>Environmental</i>	1.Green and sustainability
	2.Re-use and modification
	3.Health
<i>Traditional</i>	1.Tradition
	2.Restoration and preservation
	3.Vernacular
<i>Other</i>	1.Gender-based
	2.Economic
	3.Novel
	4.Mathematical and scientific

2.2. Optimization approaches

Since there is insignificant research made about the defined optimization techniques for the sanitary buildings the research attempt to optimize the sanitation unit by decomposing the word optimization in to its basic values. Therefore, considering the above values of architectural design based on (Ukabi, 2015), the research tried to attempt to optimize space, function and activity of the sanitation unit by the selecting the following values for the optimization of the PSU accordingly:

- Optimization of PSU as a social space
- Optimization of the PSU Aesthetical, functional & technical values
- Optimization of PSU traditional values
- Optimization of PSU environmental values

A. Optimization of PSU as a social space

Public spaces and Their Users

The built environment is a frequently applied term used to describe an artificial surrounding, designed by human beings, as well as all the relations, which take place within it. This environment is made up of buildings, complexes of building as well as their surroundings. An important element, which constitutes part of the built environment, are the public spaces. They serve to meet various human needs such as entertainment, relaxation, sports, leisure etc. Designers give public spaces forms while the form shapes the users. For users in general, the quality of the built environment has an enormous significance. Humans are building structures so they serve them and their needs. The main user together with the intended use have a great influence of the parameters of the structure. (Charytonowicz, J. 2018)

People not only stay within public spaces and take advantage of them, they also assess them. Therefore, both the built environment and the users constitute a research field and a potential source of knowledge, information of the built environment, their advantages, strengths as well as disadvantages and drawbacks (Fross 2012).

All users have the right to make an assessment. They decide whether they will use the given space or not. Of course, space created by an architect constitutes a specific offer as well as a proposition. It also possesses specific solutions. At the end of the day, however, the user makes the final choice. His or her approval constitutes a confirmation of a well-prepared functional and utility program and a correct recognition of user groups together with their needs. It is common knowledge that there are both well-designed spaces, which often become cultural meeting places, as well as badly designed spaces, which constitute asocial, uninteresting and unacceptable structures. (Charytonowicz, J. 2018)

The most important conclusion from the book, by Jerzy Charytonowicz and Christianne Falcão, advances in human factors of urban development - the users assess the structures which they make use of Public spaces are, as a matter of principle, intended for people. It does not matter if these are local residents, some visitors or tourists. Just

as our life or the way, we spend our time change, so do the requirements concerning public spaces. One might even claim that these requirements are constantly on the rise.

Quality of public space

One should also specify what creates quality in public spaces, and what specifies the norm. One might claim that the quality of space is created by a set of functional features which are looked at in technical, functional, behavioral (including esthetic), organizational and economic terms. The standard of the space, however, which is seen as an average model of that quality and constitutes a point of reference for all spaces, is specified by means of normative requirements (e.g. of the Building law) as well as by specified requirements of the market and needs of the users. (Charytonowicz, J. 2018) Spaces, which do not meet the requirements of the standard, are deemed substandard and will require either significant modernization, a redevelopment or demolition. Above-standard spaces, on the other hand, will always offer an above-average quality in terms of qualitative parameters (Fross 2012, 2015).

It has been distinguished three basic aspects of this issue: defining the space – how the living space is shaped by physical elements; configuration – how the living space is related to other spaces in a greater spatial structure; transition zones – how the physical relation among the spaces is shaped. The right solution to these aspects is the basis for the effective management of the public space. (Charytonowicz, J. (2018)

Defining the Space

The concept of space can be understood as an abstract and unlimited mathematical space or as a place – concrete and empirical space. The latter category includes the housing space. A habitat is a place on earth that is a reference point to the man's existence. The organization of the living space is, in the most general sense, the creation of here categories, in opposition to the shapeless somewhere. The creation of existential space is, in the first place, its separation from the continuum by defining the boundaries, which is the function of the architectural form (Charytonowicz, J. (2018).

Both its individual features and its location in a larger spatial configuration define the character of architectural space. There is a clear hierarchy of privacy and the division of different ways of utilization. Environmental comfort of public spaces is a result of balanced combination of varied factors, like architectural geometry of form, space arrangement of equipment, furnishing and finishing, as well as selection of materials, with their texture, surface treatment or color. Full spectrum of these elements allow architects to formulate a proper functionality, usage and safety of interiors. (Charytonowicz, J. (2018)

Transition Zones

As it has been stated, the architectural space is defined by the relation to the neighboring spaces. This applies to the spatial configuration discussed above, as well as the physical shape of the perimeter of a given space and its contact with the surrounding. The proper design of intermediate zones is of particular importance for creating harmonious connections among different zones in the habitual environment. It is important to ensure a proper balance between the separation and the connectivity of space through the view and the physical access. (Charytonowicz, J. (2018)

The boundaries, territorial gates, and threshold spaces are important for this matter. Territorial boundaries are spatial elements that articulate the change of control zones. These can be various types of fences, surface changes, or building walls. The territorial gate is a break in the continuity of the territorial border, allowing the transition to a different territorial level. The concept of the threshold space (or doorstep) connects to the idea of the boundary and the gate. The threshold space occurs in the joint of spaces with different levels of privacy. Its task is to mitigate the rapid transition between different territorial zones. The proper shape of the transition zone should take into account the nature of the external space, towards which the building is oriented. (Stephens, 2014)

Conclusions

The analysis of different aspects of form and territory allows formulating the general characteristics of the sustainable efficient architecture. The architectural form should legibly define the private space. This enables to develop the territorial structure. At the

same time, there should be a balance between closures and openings to avoid the impression of being trapped or lost in the space.

Defining the space should not take place at the expense of ventilation, insulation. Contact with nature. The formation of transition zones should ensure the possibility of maintaining privacy and establishing social contacts at various levels.

B. Optimization of the PSU Aesthetical, functional & technical values

Spatial quality- Spatial quality optimization is concerned with finding feasible locations and dimensions for a set of interrelated objects that meet all design requirements and maximize design quality in terms of design preferences. The spatial configuration is relevant to all physical design problems, so it is an important area of inquiry. Another approach to representing the building layout design space is to decompose the problem into two parts: topology and geometry. Topology refers to logical relationships between layout components. Geometry refers to the position and size of each component in the layout. Topological decisions define constraints for the geometric design space (Medjdoub & Yannou, 2001).

Technical quality – analyzed as satisfactory state of upkeep and maintenance of buildings and the whole infrastructure of the surroundings. State of development and upkeep of land around the buildings in the context of ensuring repairs and removing the reported damage. Upkeep of a building in view of its age, durability of materials, materials used (insulation, removing asbestos cardboards, replacement of doors and windows, application of materials resistant to damage, etc., works connected with maintenance management). Technical quality embraces technical and technological facilities, condition of the surface, provision of the elements of small architecture, transport efficiency, number of car parks, transport system, pedestrian walkways, level of security, monitoring and condition of street lighting, pedestrian ways, urban interiors, and building entrance zones. (Charytonowicz, J. 2018)

Functional quality – according to (Charytonowicz, J. 2018) functional quality is characterized by proper location, transport connections, structure of the nearest neighborhood, structure and composition of analyzed layout, including urban interiors, entrance zones, arrangement of forms of social activity, as well as the distribution of the occasion, problem generators. Functional solutions are analyzed paying special

attention to adaptation of the size, composition and solutions of the common space, which enables the activity of users of the given space (simultaneously eliminating unfavorable behavior, that is, occurrence of antisocial behavior). The quality in question includes functioning of buildings and space resulting from grouping the function related to the hierarchy of space influencing its accessibility.

Such elements are essential as access to collective services and transport, definition of the way of implementing the social needs of the users, that is: composition of greenery, playgrounds, recreation grounds for children and adults, availability for old and disabled people (elimination of architectural barriers in respect of providing community integrating places, because a better-consolidated community identifies with the dwelling place, cares for it and is more inclined to provide help). Research include safety – resulting from functioning in a wider structure – impact of neighborhood, potentially dangerous places, paths and driveways – safety of traffic which has effect on the frequency of making use of grounds, appropriation of places by cars, frequency at which people appear in the day/night space, possibility to make use of the land thanks to attractiveness of development, elimination of the poorly lit places. (Charytonowicz, J. 2018)

Behavioral quality - including also the aesthetic one – concerns human behaviors and individual emotions experienced under the influence of the surrounding space. It is examined as fulfilment of comfort, sense of security. In this case, the composition is essential, which creates the space hierarchy assuring privacy, territoriality. An important matter is the comfort of use, fulfilment of social needs, occurrence of integrating places for people residing in a given part of space, satisfaction, pleasure of staying in a given space. Under consideration are applied design solutions, equipment, small architecture facilities, quality of lighting and the number of light points, color, materials, and greenery the sense of climatic comfort (quality of air, pollution, sound level, and transport nuisance). (Charytonowicz, J. 2018)

According to (Charytonowicz, J. 2018), appearance of the development concept is essential: applied form, color scheme, texture of buildings, and the state of upkeep and maintenance of buildings and the surrounding space in the context of impact on aesthetic impression. The scale of development concept has also a great significance in the feeling of the space. Sense of security, actually, its lack related to the existence of

potentially dangerous places. Fear appears wherever a pedestrian feels uncertain. Any dark, poorly lit and remote paths and driveways can evoke anxiety. Neglected and desolate places are also hostile. Behavioral quality is connected with good orientation in space, ease of finding the way, elimination of the feeling of loss and fear.

C. Optimization of PSU traditional values

Human factors

According to (Charytonowicz, J. (2018)), the key to solving microplanning problems is the user and its environmental and phenomenological perception - a human factor. The perception, also called cognizance or impression, refers (similarly as aesthetics) to the perception of human phenomena or processes occurring as a result of the action of specific stimuli on our sensory organs. It includes not only a complex, subjective cognitive process, not only experience and memory but also brings its activities (expectations, values, goals, security, etc.) into the environment. It should also not be forgotten that the perceptual processes are significantly influenced by culture.

According to the International Ergonomics Association, “Human factors is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance.” (Standardization., 2010) Human factors is therefore concerned with applying what is known about human behavior, abilities, limitations, and other characteristics to the design of systems, tasks/activities, environments, and equipment/technologies. It is also concerned with the design of training programs and instructional materials that support the performance of tasks or the use of technology/equipment.

In terms of human factors, it is decisive for the health, safety, wellbeing and comfort of users. The design stage is also crucial for optimization of all aspects, because a virtual project is representation of a real object to be physically built and used for years in specific climate and site conditions by users, who can additionally influence performance of a building. (Charytonowicz, J. (2018))

Social factors

The social acceptance related to the use of devices intended for both sexes (without gender segregation) may vary. In many cases, it is assumed that facilities for men and women should be located separately, but universal (unisex) are often used. If a sense of security, privacy and intimacy is assured and a number of users is small, then such an approach may be completely acceptable. The balance between men and women's facilities is often difficult to predict and estimate because the needs and requirements of users vary. Generally, men spend less time in the toilet than women do. Women, due to anatomical and biological reasons and due to the way they dress, need more time to use the toilet than men do. In addition, women often use toilets together with babies and small children. For the above reasons, they have much more needs in terms of using public toilets. They use them more often than men do. They also require more space inside the toilet stall. (Hendricks, 2018)

According to (Harvey Molotch and Laura Noren, 2010), the effective scope of rest room provision may partly depend on:

- The legal regulations regarding hygiene and public health,
- The social acceptance of unisex facilities,
- The right balance between facilities for men and women (equal access),
- The need to adapt the facilities to the requirements of people with disabilities,
- The need to adapt the facilities for small children use (mothers with small children),
- The possibility of using the area by larger tour groups.

Physical factors

According to (National disability Authority, 2012) People with disabilities need in most cases separate rooms, equipped with additional space for wheelchair access, special handles, handrails, specialized devices mounted at appropriate heights and other amenities. In a large building or a small unit, it is worth providing best accessible infrastructure units for the disabled both in the women and men's zone. Another reason for favoring a unisex toilet is the fact that a person of the opposite sex can accompany a person with a disability.

Ergonomics

Nowadays, mutual relations between user and building and between users are complex and changing. Ergonomics is a condition for optimization, which in turn assures financial feasibility and human oriented acceptability and comfort. This is also indispensable condition to achieve the postulate of synergy of design aspects. If any of them is a failure, there will be no proper or full effect of synergy. Moreover, this synergy, achieved by ergonomic optimization applied to all areas of a design, conditions the three pillars of sustainability: social, ecologic and economic. In practical approach, these three categories intermingle. Each action in one influences another or both of the other two.

Optimization in architectural design process means to achieve the best possible and financially feasible solution of all problems and tasks in a given situation. To understand that, one needs to keep in mind that each architectural object is unique – even in repetitive objects the set of site conditions may very significant to have influence on final result. However, the aspects that have to be considered are not only material. In architectural design important are also mental comfort of users, individual taste of client traditional or preferred ways of behavior, cultural background, and many other related to particular client/user/location. Among the key factors deciding on the size and proportions of rooms of a space there are:

- Number, types and sizes of fixed and mobile equipment distributed in a room,
- Freedom of access to the equipment related with the movement area of an individual (Size and mobility),
- The way of distribution of equipment (furniture arrangement),
- providing of conditions for safe and comfortable usage of a room and individual Pieces of furniture,
- providing of conditions for changing of the arrangement (changing of placement of equipment or its replacement),
- Social, cultural and psychological requirements.

According to (Charytonowicz, J. 2018), Spatial and mobility requirements of people with various levels of fitness should be assumed as benchmarks used for shaping of a space and ways of distribution of elements, which fill it. What is vitally important is taking into consideration of particular needs of people with lower mobility (disabled people, children, the elderly and people suffering from obesity). The possibility of rearrangement of furniture within single rooms or functional zones determines the level of flexibility of adjustment of space to changing needs of their users.

Relationship of Ergonomics and Sustainable Development

Ergonomics is established and indispensable part of the architectural design if it is to respect human as a center of reference and measures. Thus, ergonomics as an approach in design process needs the same shift in the light of sustainable development. From the point of view of architectural practice, with its interdisciplinary character and holistic view, adopting ergonomic design to new demands first needs extending the scope of issues considered. (Pavlovic-Veselinovic, 2014) Designs should be sustainable as not only green buildings, but also being safe to build, maintain and use, and that “A building that fails to promote the health and welfare of its occupants cannot be considered sustainable”. Further examples of health, safety behaviors and inclusion of disabled and elderly issues showed social and economic aspects of sustainable design that was discussed in the context of useful tools, which ergonomics can provide to help solving these issues. Conclusions of the discussion responded exactly to holistic approach principle of the sustainable design, defined as described here earlier in reference to architecture. Formulated by ergonomist, those conclusions sounded like choir with architects’ postulates: “In essence, today’s successful (sustainable) design implies synergy of the best technical, environmental, ergonomic, economic and social solutions for present and future all the more complex systems.” (Pavlovic-Veselinovic, 2014)

Catchment centrality

As it is discussed on the literature review, (Paolo Crucitti, etal 2005), the consequence of events depend on the topological characteristics of cities, which are the result of the particular growth process and geography of a place. Centrality is relevant for various spatial factors affecting human life and behaviors in cities. As the researchers have presented in their work on comprehensive study of centrality distributions over

geographic networks of urban streets, five different measures of centrality, namely degree, closeness, between-ness, straightness and information have been analyzed.

Centrality measures serve to quantify that in a network some nodes are more important (central) than others. The idea of centrality was first introduced in the context of social systems, where it was assumed a relation between the location of an individual in the network and its influence and/or power in-group processes. Since then various centrality measures have been proposed over the years to quantify the structural centrality of an individual in a social network, and the issue of centrality has found many applications in biology and technology. When dealing with urban street patterns, centrality has been a main concern.

D. Optimization of PSU Environmental values

Towards Water sensitive public sanitation

According to (United Nations, 2014), Global warming, population growth, urbanization and growing consumption of water and energy continue to disrupt our already fragile ecosystem. These unsustainable trends are reinforced by market and political drivers that still tend to favor further developments of water intensive activities in arid and semiarid areas where there is not much water available. This is also a trend in emerging economies some of them in Asia and Africa are dangerously short of water. (United Nations, 2014)

However, infrastructures are only one part of the assets required for the provision of the water and energy services we depend on. Human development depends also on the environment which is a complex collective asset that ultimately provides the water and energy services, on which life and the economy depends on. Moreover, increasing and competing demands on water and energy as well as the changes required to cope with them may compromise the potential of nature to sustain economic progress and continue providing other valuable environmental services. (United Nations, 2014)

Restoring the balance between natural and human made infrastructures needs to be recognized as an important element to reconstruct water and energy access. Restoring impaired ecosystems by recovering some of the basic functions performed in the past can be a valid cost effective alternative to reduce risks and exposure in many different ways. Water sensitive development involves simple design and management practices that take advantage of natural site features and minimize impacts on the water cycle. It

is part of the contemporary trend towards more ‘sustainable’ solutions that protect the environment. (United Nations, 2014)

Rainwater harvesting

Rainwater harvesting is a technique for providing water to humans that has been used across the planet since the dawn of time. Recent generations have come to take the rainfall for granted. Their primary goal was to treat the runoff as a problem instead of an asset. Understanding the overall water cycle and looking at the effects of rainwater harvesting on the environment help us understand how it can be one of the methods to providing water for our growing demand. (Mechell et al., 2009)

According to (Mechell et al., 2009), Implementing rainwater-harvesting techniques directly benefits the country and state by reducing the demand on the municipal and public water supply, along with reducing run-off, erosion, and contamination of surface water.

Estimating the amount of water that can be harvested in a given area depends on the catchment area, rainfall, system efficiency, and a design safety factor. The interpretation of each of these essential variables directly effects the planner’s estimation. The catchment area and rainfall amounts must be determined accurately for the system to work to its fullest potential. System efficiency relates to spillage, leakage, and losses due to materials. The planner may choose to utilize a design safety factor that provides for the underestimation of the catchment potential so that there is a cushion for the system functionality.

Since Wurerber is one of the pilot rural centers for development, it should be an example for the other developments. In this case, an easy rainwater harvesting system should be applied accordingly. According to (Mechell et al., 2009), Rainwater can be filtered, sanitized, and used for non-potable and potable water in homes and businesses instead of other water sources.

Pressure systems

The variables that need to be determined include average monthly rainfall (inches), catchment footprint (square feet), runoff coefficient and safety factor. (Mechell et al., 2009)

A pressure system involves using a pump to deliver rainwater to household or garden fixtures. Pressure Systems are required where the tank cannot be installed at a sufficient height to provide acceptable pressure. The device operates by filtering roof runoff through a mesh screen to capture leaves and debris. The first part of runoff is stored in the chamber to slowly trickle through a small hole whilst cleaner water at the top of the chamber passes into the rainwater tank. (Mechell et al., 2009)

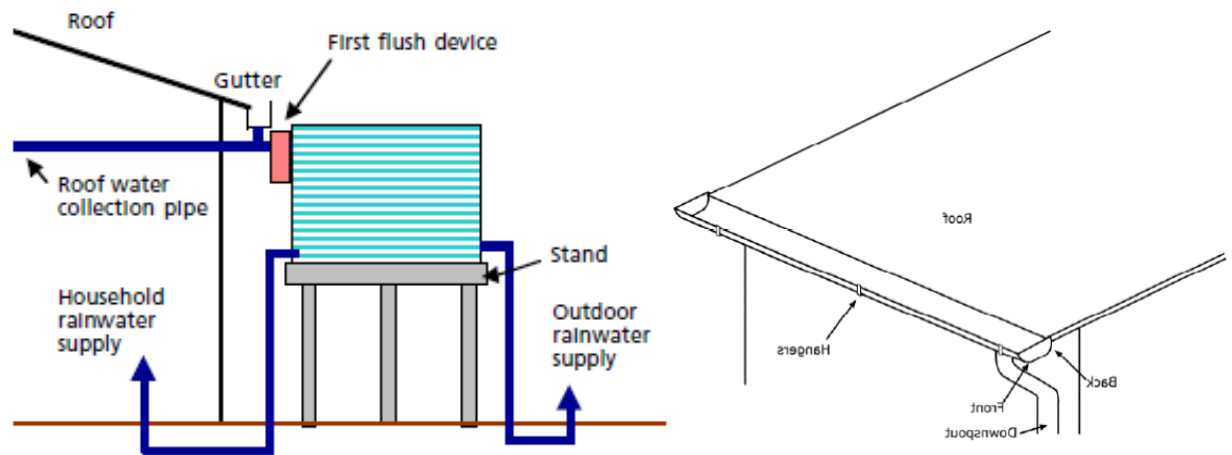


Figure 3 Rainwater harvesting sample, source (Mechell et al., 2009)

Simple Estimate

A simple estimate of the number of gallons that can be harvested from a given catchment area from a rainfall event can be determined with the following formula. The total number of gallons harvested is equal to the catchment area (square feet) times the depth of a rainfall (inches) times a conversion factor of 0.623. (Mechell et al., 2009)

$$\text{Harvested} = \text{catchment} \times \text{depth} \times 0.623$$

water (gal) area (ft²) (in.) conversion factor

The following table illustrates supply estimates in gallons from rainfall amounts that range from 1 to 15 inches and catchment areas of 2,200, 3,500 and 5,000 square feet. The number of gallons per square foot of catchment area is also provided. Although this formula provides a rough estimate that might be adequate to initiate a discussion with a client, a more comprehensive approach is necessary to provide an adequate estimate. (Mechell et al., 2009)

Catchment Area

The catchment area is the location from which the water is collected and must be measured to the nearest square foot. The total roof area is not as important as the footprint of the catchment, which determines the area in which water is collected. Regardless of the complexity of the angle or shape of the roof, the footprint area is always smaller than the actual area. (Mechell et al., 2009)

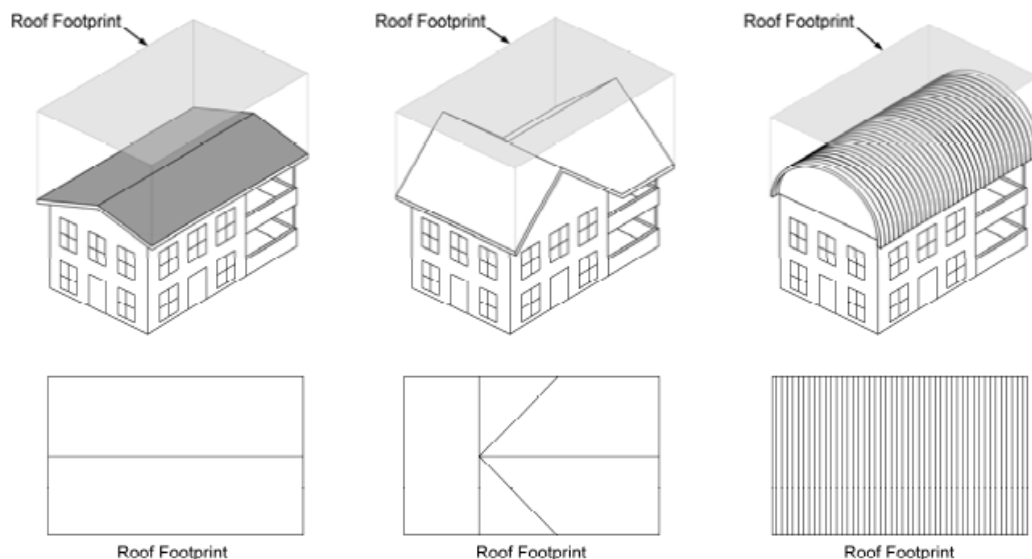


Figure 4 Catchment area typologies; source (Mechell et al., 2009)

Catchment Surface Runoff Coefficient

According to (Mechell et al., 2009), The material and texture of the catchment surface has an effect on the amount of water harvested. A rough and/or absorptive surface conveys less rainwater than a smooth surface. A rough and/or absorptive surface conveys less rainwater than a smooth surface. For example, a catchment surface made of grass, soil, rocks, asphalt shingles, or rough concrete will retain some water before it begins to runoff. These surfaces decrease the efficiency of a RWH collection system by allowing infiltration or absorption or facilitating evaporation of the water. In contrast, a smooth metal surface will minimize these losses. In order to compensate for inefficiencies, a catchment surface runoff coefficient is applied to the calculation for supply estimation. In order to compensate for inefficiencies, a catchment surface runoff coefficient is applied to the calculation for supply estimation.

Design Safety Factor

For centuries, design engineers have used a safety factor (known commonly as a fudge factor) to overestimate or underestimate performance in their designs. In the planning process for RWH, a safety factor should be used to underestimate the potential for rainfall catchment. A design safety factor that ranges between 0.95 and 0.65 should be considered. (Haan, C.T., 1994) & (Waterfall, 1998)

Table 2 High and low runoff coefficients for various catchment surfaces. (Source (Haan, C.T., 1994) & (Waterfall, 1998))

Run-off Coefficients*		
Character of Surface	High	Low
Roof		
Metal, gravel, asphalt shingle	0.95	0.75
Paving		
Concrete, asphalt	0.95	0.70
Brick	0.85	0.70
Gravel	0.70	0.25
Soil		
Flat (2% or less), bare	0.75	0.20
Flat (2% or less), with vegetation	0.60	0.10
Lawns, Sandy Soil		
Flat (2% or less)	0.10	0.05
Average (2% to 7%)	0.15	0.10
Lawns, Heavy Soil		
Flat (2% or less)	0.17	0.13
Average (2% to 7%)	0.22	0.18

Ground water borehole

To meet increasing urban water requirements in a sustainable way, there is a need to diversify future sources of supply and storage. Ground water serves the great majority of people who live in rural areas and have a water-supply system of one type or another. The reason is that, among the various sources of supply, ground water is by far the most practical and safe in nature. Even in a highly industrialized country such as the USA, municipal ground-water installations far outnumber surface water supplies. It is very

probable that, for a long time to come, ground water will be the most important source of supply for most rural communities of the world.

The advantages of ground water are:

- it is likely to be free of pathogenic bacteria;
- generally, it may be used without further treatment;
- in many instances it can be found in the close vicinity of rural communities ;
- it is often most practical and economical to obtain and distribute;
- The water-bearing stratum from which it is drawn usually provides a natural storage at the point of intake.

Groundwater extracted from bores can be an important water source for domestic use. Many urban areas occur over a suitable aquifer. Aquifer storage and recovery involves the injection of treated storm water into a suitable aquifer. This water is stored in the aquifer for extraction and reuse later.

Borehole

A groundwater bore comprises a well driven into the ground to a depth exceeding the water table (the uppermost level of strata that is saturated by groundwater). Water-bearing strata beneath this level (such as rock or sand) is termed an aquifer. The depth of the water table and aquifers varies considerably from place to place in response to geological and climatic conditions, and can also vary seasonally. (UNICEF, 2012)

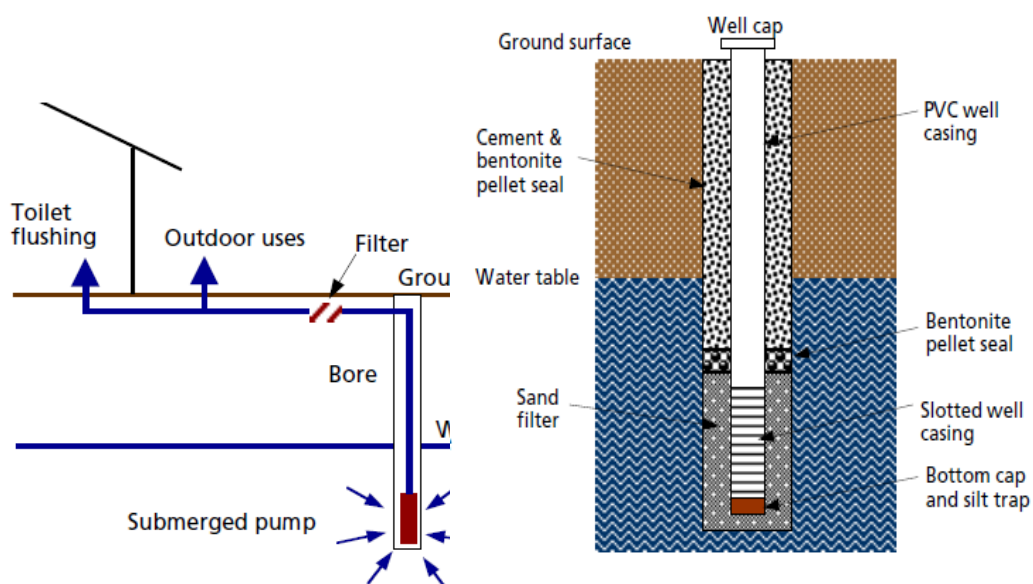


Figure 5 Borehole system and construction. Adopted from (UNICEF,2012)

Boreholes shall be drilled to such depths as to penetrate below the shallow water table aquifers and tap the first potential deeper aquifer or aquifers in confined/semiconfined conditions with a minimum discharge of *0.25 liters per second* to sustain continuous pump testing for 6 hours to ensure reliable operation of hand pumps fitted on them. Sand trap will be part of the well design when boreholes are cased to the bottom. The sand trap will be from UPVC casing pipe with specifications described above, fitted to the end of last screen and bottom end with an end-cap. (UNICEF, 2012)

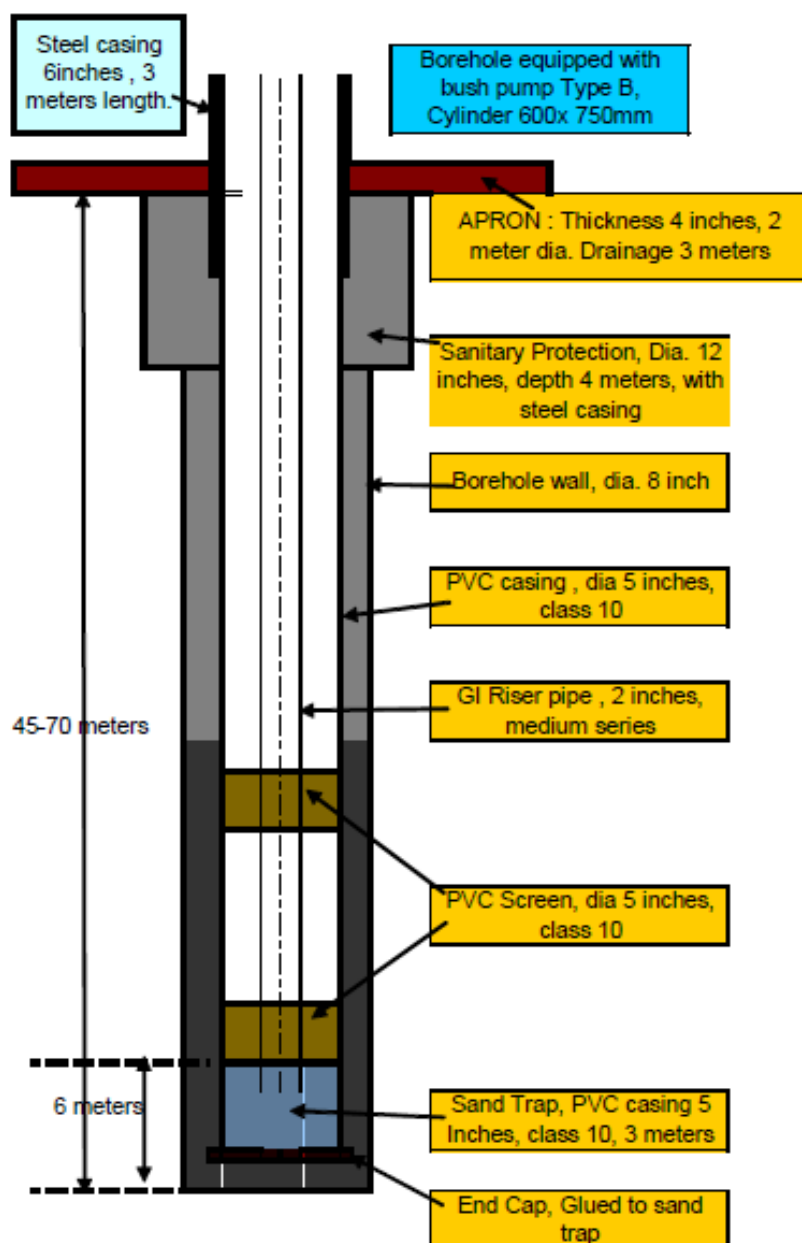


Figure 6 Borehole sample, source: UNICEF 2012

Wastewater treatment and ground water recharge

Anaerobic Baffled Reactor (ABR)

An Anaerobic Baffled Reactor (ABR) is an improved septic tank because of the series of baffles under which the wastewater is forced to flow. The majority of settle able solids are removed in the sedimentation chamber at the beginning of the ABR, which typically represents 50 % of the total volume. The up flow chambers provide additional removal and digestion of organic matter: BOD may be reduced by up to 90 %, which is far superior to that of a conventional septic tank. As sludge is accumulating, desludging is required every 2 to 3 years. (Morel A. and Diener S., 2006)

Adequacy: this technology is easily adaptable and can be applied at the household level or for a small neighborhood. An ABR can be designed for a single house or a group of houses that are using a considerable amount of water for clothes washing, showering, and toilet flushing. It is mostly appropriate if water use and supply of wastewater are relatively constant. (Morel A. and Diener S., 2006)

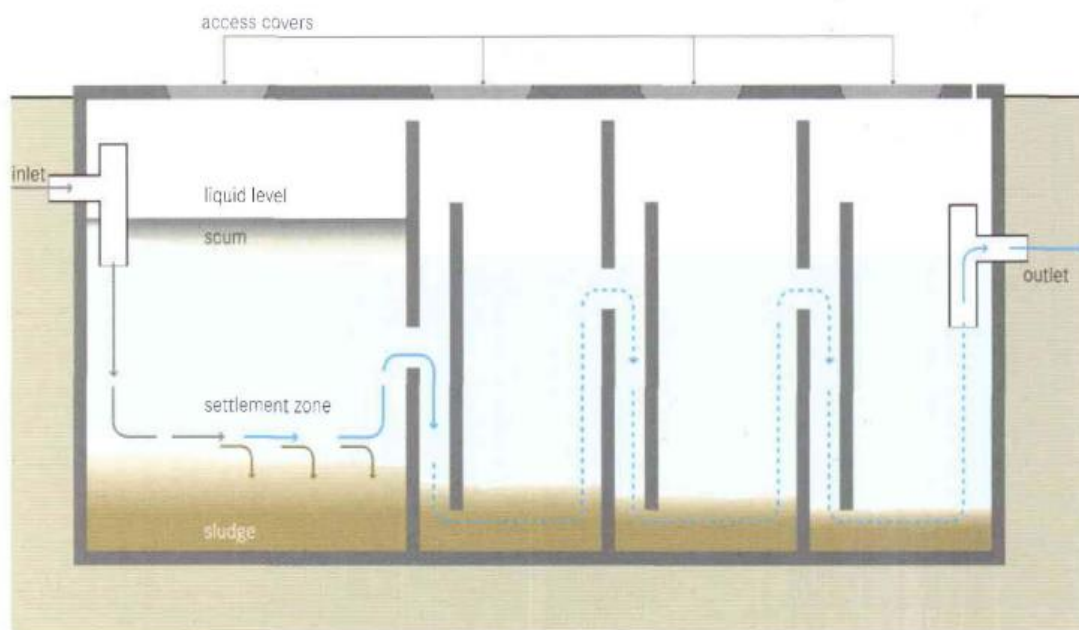


Figure 7 Anaerobic Baffled Reactor (ABR), Source: (Morel and Diener, 2006)

Health Aspects/Acceptance

Although the removal of pathogens is not high, the ABR is contained so users do not come in contact with any of the wastewater or disease causing pathogens. Effluent and sludge must be handled with care as they contain high levels of pathogenic organisms. To prevent the release of potentially harmful gases, the tank should be vented.

Maintenance

ABR tanks should be checked to ensure that they are watertight and the levels of the scum and sludge should be monitored to ensure that the tank is functioning well. Because of the delicate ecology, care should be taken not to discharge harsh chemicals into the ABR. The sludge should be removed annually using a vacuum truck to ensure proper functioning of the ABR. (Hudson, 2010)

Pros & Cons: according to (Hudson, 2010)

Pros:

- Resistant to organic and hydraulic shock loads
- No electrical energy required
- Greywater can be managed concurrently
- Can be built and repaired with locally available materials
- Long service life
- No real problems with flies or odors if used correctly
- High reduction of organics
- Moderate capital costs, moderate operating costs depending on emptying; can be low cost depending on number of users

Cons:

- Requires constant source of water
- Effluent requires secondary treatment and/or appropriate discharge
- Low reduction pathogens
- Requires expert design and construction
- Pre-treatment is required to prevent clogging

Treated water infiltration

Infiltration devices can be utilized to promote a variety of water management objectives including increased ground water recharge, reduced down street flooding, reduced peak storm water discharges and improved storm water quality. A leaky well consists of a vertical perforated pipe with a lid at the ground surface and an open bottom. The wastewater enters via an inlet pipe at the top and an overflow pipe caters for excess wastewater. The holes in the walls and the open bottom are covered with geotextile fabric to cleanse wastewater as it percolates to the surrounding soil. The leaky well stores storm water until it percolate to the soil. The leaky well is incorporated to the waste treatment system so that the effluent comes from this will be led into the next leaky well chamber for further treatment and infiltration. (Coombies, 2002)

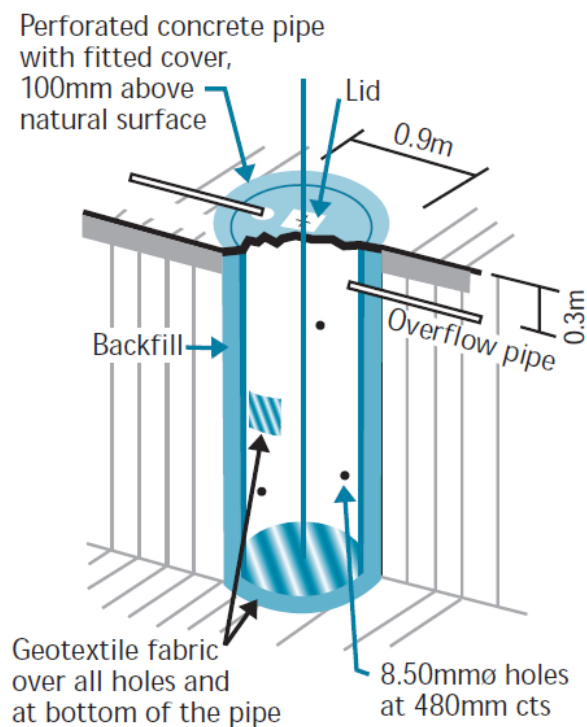


Figure 8 The leaky well infiltration system, Source (Coombies, 2002)

2.3. Criteria for the design of hygienic and sanitary objects

According to the book edited by Jerzy Charytonowicz & Christianne Falcão *Advances in Human Factors, Sustainable Urban Planning and Infrastructure* published in 2018, Criteria for the design of hygienic and sanitary objects surrounded by natural

landscapes: according to the importance of buildings, shelters and toilets are presented below: (J. Charytonowicz & C. Falcão 2018)

- Selection of the appropriate location of the object in the context of the site
 - taking into account how an object can be adapted for possible increase of use and supporting infrastructure, such as paths, access to vehicles, parking lots (objects may affect the increase of pedestrian and vehicular traffic in a given area, which is a strain for a sensitive environment),
 - locating objects into the landscape avoiding open spaces, on the outskirts, in order to minimize negative visual impacts,
 - combining or grouping structures as much as possible to minimize the overall visual impact,
 - locating objects on the background of greenery to reduce the visual impact,
 - locating objects near the area with the highest activity to optimize their use,
 - providing safe and legible access, without confusing camouflage,
 - Analysis of the time and manner of using facilities by users in order to provide additional means of transport or necessary parking spaces.

- Designing the appropriate form of the object and the internal functional and spatial arrangement
 - ensuring that the building corresponds with the particular history of the place, culture, landscape and local community,
 - the use of forms and materials that can help in the interpretation and reference,
 - careful selection of the cladding of buildings, bearing in mind their integration with the surrounding landscape, and at the same time resistance to graffiti,
 - defining the range of user groups and their individual needs and requirements,
 - ensuring accessibility for users of all ages and physical abilities,
 - if possible, shaping multifunctional structures to ensure the best practicable use,

- if possible, incorporating flexibility into the building design so that it meets a number of current or future user needs,
 - orienting views from objects towards the landscape to emphasize important view lines,
 - Providing basic amenities and toiletries, including soap, toilet paper and hand dryers or paper towel, to promote hygiene and public health.
- Achieving a sustainable building architecture
 - the use of energy efficient design principles, the use of energy efficient light sources, the use of solar energy, the use of renewable materials,
 - the use of on-site generated energy (if possible) and including it within the implementation costs (e.g. taking into account the costs of solar panels),
 - the use of the sustainable water management function, the use of water efficient appliances, for example low-flush toilets, and water-saving taps,
 - collection and use of rainwater for flushing toilets, – the use of green roofs for rainwater detention and filtration, – Providing external shady places for shelter.

Architecture of Public Toilets in the Landscape

- Ensuring well maintenance and management of the facility
 - Allowing easy regular maintenance, ensuring easy access for service vehicles & a selection of building materials that can be easily transported to a location, preferably local materials, the use of resistant materials and strategic solutions aimed at counteracting acts of vandalism.

Chapter Three: Contextual framework

3.1. Project location

The project is located in Wurerber village, Cheha Woreda, gurage zone, Ethiopia. There are different neighborhoods present nearby in 2.5 km radius which are administrated under Wurerber wesherbe kebele, like Amora meda, yefeterek wodro, Atoshe Aturche...etc.

Part of the Gurage Zone, Cheha is bordered on the south by Enemorina Eaner, on the west by the Oromia Region, on the north by the Wabe River which separates it from Abeshge and Kebena, on the east by Ezha, and on the southeast by Gumer and Geta. The administrative center for Cheha is Endibir; other towns include Gubre. Elevation of Wurerber ranges from 1900-2000 meters from sea level. (Adopted from unjobs.com)

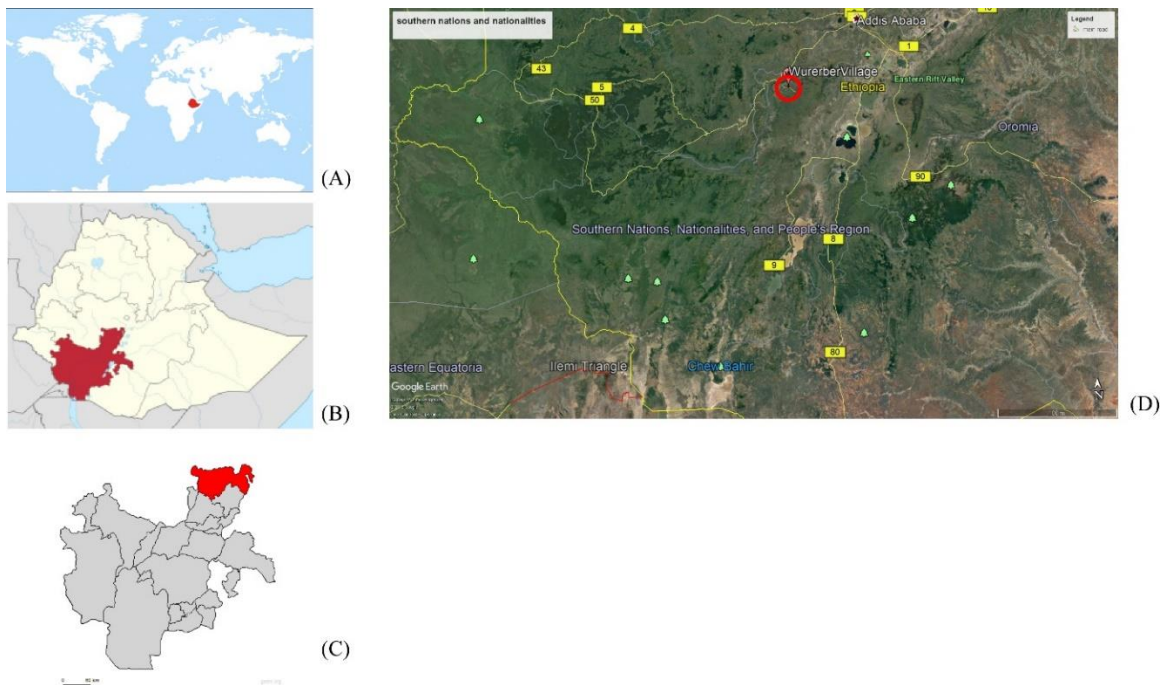


Figure 9 Project location. Source: Google earth, ArcMap

(A) World – Ethiopia, (B) Ethiopia – southern nations & nationalities, (C) Southern nations & nationalities – Gurage zone, (D) Gurage zone - Cheha Woreda – Wurerber Kebele.



Figure 10 Location of Wurerber Kebele, Source google earth pro. June 2019

Cheha is one of the Woredas in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. This Woreda is named after one of the sub-groups of the Sebat Bet Gurage, the Cheha.

3.2. Demography of Wurerber Kebele

Wurerber is a small village having a total estimated number of population of 2621, with 535-estimated number of households. (Wurerber Kebele health center report, 2018)

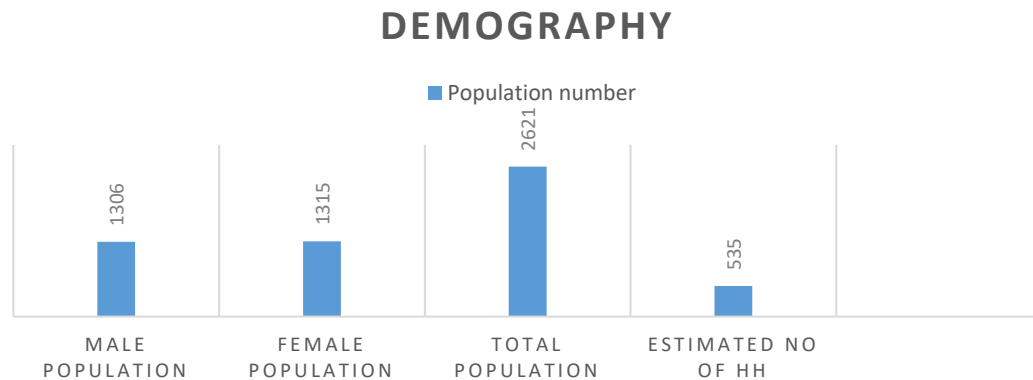


Figure 11 Demography of Wurerber, source; (Wurerber Kebele health center report, 2011)

3.3. Climate

Based on the elevation difference of the Kebele(1900m-2000m) the climate zone of Wurerber Kebele is Woina dega (Subtropical zone) - includes the highlands areas of 1830 - 2440 meters in elevation has an average annual temperature of about 22 degree Celsius with annual rainfall between 510 and 1530 millimeters'. (Climate-data.org)

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	18.5	19.5	19.9	20	19.5	18.2	17.5	17.2	17.7	17.9	17.9	18
Min. Temperature (°C)	10.2	11.2	12	12.7	12.3	11.8	12.2	11.8	11.2	10.1	9.8	9.1
Max. Temperature (°C)	28.9	27.9	27.9	27.3	28.8	24.7	22.9	22.8	24.2	25.8	28	27
Precipitation / Rainfall (mm)	22	37	76	80	128	170	233	245	157	48	15	12

Figure 12 Average climate data of Gubre, source: Climate-Data.org.

3.4. Description of the Wurerber public sanitation unit project (PSU)

A. Stakeholders of the PSU

One of the stakeholder of the Wurerber integrated infrastructure unit was ECL-AA, Emerging city lab under Ethiopian Institute of Architecture and building construction, Addis Ababa University. The second is, the Bauhaus University, Weimar, which is one of the leading universities in Germany. The third one is Flint stone homes company, which is involving in the countries real-estate projects and working in collaboration with ECL-AA. The last project stakeholder were the Cheha Woreda Administration, which shows a high interest in the project and working with the project initiators up to completion and still supporting the unit.

B. What is IN³?

Integrated Infrastructure (In³) is an interdisciplinary international research project at the Bauhaus-Universität Weimar (BUW) and the Ethiopia Institute for Architecture, Building Construction and City Development (EiABC). The main objective of Integrated Infrastructure is to create knowledge, tools, and networks for establishing high-quality, interdisciplinary, cross-continental research and education on planning and building of resilient cities in Ethiopia and Germany. Starting from the premise that

the technical infrastructure (water, energy, transport) acts as a main driver for spatial and thus social developments. IN³ focus on the development and implementation of an integrated planning strategy (IPS), that helps to anticipate the technical infrastructure in the planning and implementation of spatial structures (buildings, streets, lots, public spaces) in the best possible manner.

C. Overall approach of IN3 project

The primary idea of IN3 is applying in the general approach, which could fit in most situations in rural areas of Ethiopia. The distinct physical appearance of the regional habits, available materials and the existing level of technical practice demands different component solutions for the water cycle and environmental sustainability. Therefore, to illustrate this the project called ‘**Aqua nostra & Neue Mitte**’ or ‘**የኛ ውሃ አዲስ ማዕከል**’ is presented in rural Ethiopia.



*Figure 13 Physical setting and appearance Public sanitation unit in rural context.
Photo by Jacob. May2019*

D. Aim of the Integrated Infrastructure project

The overall aim of the project was an implementation of an improved sanitary concept for personal hygiene combined with an attracting point, which invites to rest and to gather. Water points are the centre for social actions take place for community members who carry water from. When those water points serve additional offer like - showering and washing – raise the functions and attract more of the surrounding people, which were not yet attracted by. (Unpublished document)

These actions bring the geometrical centre of a rural settlement to live in a social way and convert this into a real, lively centre of the upcoming town. The nucleus will attract small businesses, expand the social ties and improve the hygiene situation. Improved sanitary concept includes a proper work on drinking water distribution and a proper treatment of the wastewater. Both were the part of the project.

E. Technical framework considerations

The shower unit was designed to serve as a shower and a washing unit to the neighbourhood in the emerging rural areas of Ethiopia. The design provides just one bathroom with three showerheads. By this design, this shower has to be used with different timeslots for male and female users. The concept avoids different problems:

Cost-effective: Reducing one of two bathrooms saves space and material and rise the occupancy rate of use. However, this design offers on the other hand more space for changing cloth and individual space for each gender. Separate timeslots save material and space but offers more used space instead.

Gender: any solicitudes males bothering the womankind could be excluded with separated timeslots. The private space will be used only by one gender and no male/female will be disturbed by changing clothe of the opposite sex nearby

The wastewater: of the shower is technically spoken light greywater (Bath/showering). Wastewater from cloth washing is under western circumstances heavily loaded greywater due to the savings of water in the mechanized process of washing and the application of several chemical detergents to the cleaning agents.

This is not expected in the rural areas. Hence, the treatment process is designed for light greywater.



Figure 14 Public sanitation unit in Wurerber. Photo by the author, May 2019



Figure 15 PSU water supply tap and greywater treatment system. Photo by the author, May 2019.

Chapter Four: Research method

4.1. Introduction

This study aims to discover the factors for the underutilization of the PSU in Wurerber. This section describes the research design adopted for the study and the data collection methods employed, and how the data was analyzed. It also provides a method adopted for the respondent sample size & selection procedure involved.

4.2. Research design

Descriptive research

This research adopted the Descriptive research method as a research design for the collection of data on finding the mismatch of the unit setup and the underutilization of the public sanitation unit. I have adopted Descriptive research because it is one of the fundamental methods of research methodology. According to (Sherman, 2014), this research is often referred to as questionnaire or opinion study. It may serve as a reconnaissance phase of an investigation in a new area in which the purpose is to identify factors, which are most promising for experimental investigation. This method is used as a check on laboratory findings in real life and used as a tool in identifying norms of standards with which to present conditions for planning future. It describes and interprets what it is with reference to conditions or relationships that exists, opinions that are held, processes that are going on, effect that are evident, or trends that are developing. (Sherman, 2014)

Other reason for selection of a Descriptive research is that it aims at portraying accurately the characteristics of a particular group or situation. (Megel & Heermann, 1993) Descriptive research answers the questions, what, who, where, how and when. It is used to study the current situation. A descriptive study may be concerned with the attitude or views (of a person) towards anything e.g., attitudes presidential form of government, right to strike, capital punishment, prohibition, college autonomy etc. (Megel & Heermann, 1993)

Steps of Descriptive Research

According to a study made by Grosser in the year 2013, a descriptive research involves the following steps: The Clear discrimination of objective of Research First step is to select the main purpose of research it is necessary because for proper study of research. Without main aim and purpose, research cannot go properly. Determination of the Method of Data Collection For any research method, data collection is necessary which type of research the researcher want, he must have to select the method like questionnaire observation, interview etc. of their research. Selection of Sampling The place which is selected by the researcher, there must be many people so it is difficult to make contact with all persons this the researcher select some people these selected people are known as sampling selection of sampling have some essential terms. Real Collection of Data For real collection of data, the researcher must have to in his real research field, and it is collected in a selected step at the time of data collection reality is necessary for investigation. Analysis of Achieved conclusion After the collection of data the researcher makes the conclusion of the whole research or investigation for conclusion coding, tabulating and graph representation is used. (Grösser, 2013)

4.3. Research strategy

Approaches to the descriptive research

As an approach for the descriptive research, this research uses observational and survey method research. With the observational method (sometimes referred to as field observation) human behavior is closely observed. In survey method research, participants answer questions administered through interviews or questionnaires. After participants answer the questions, researcher describe the responses given. (Hood, Brandner, & Himes, 2016) Surveys are a very traditional way of conducting research. They are particularly useful for non-experimental descriptive designs that seek to describe reality. Surveys can take many forms. A survey of the entire population would be known as a census. However usually surveys are restricted to a representative sample of the potential group that the researcher is interested in, for reasons of practicality and cost-effectiveness. Most surveys take one of the following forms: cross sectional survey and longitudinal survey. From this regard, the research is cross sectional survey, that are carried out at a just one point in time and it provides a snapshot of what is happening in that group at that particular time. (Hood et al., 2016)

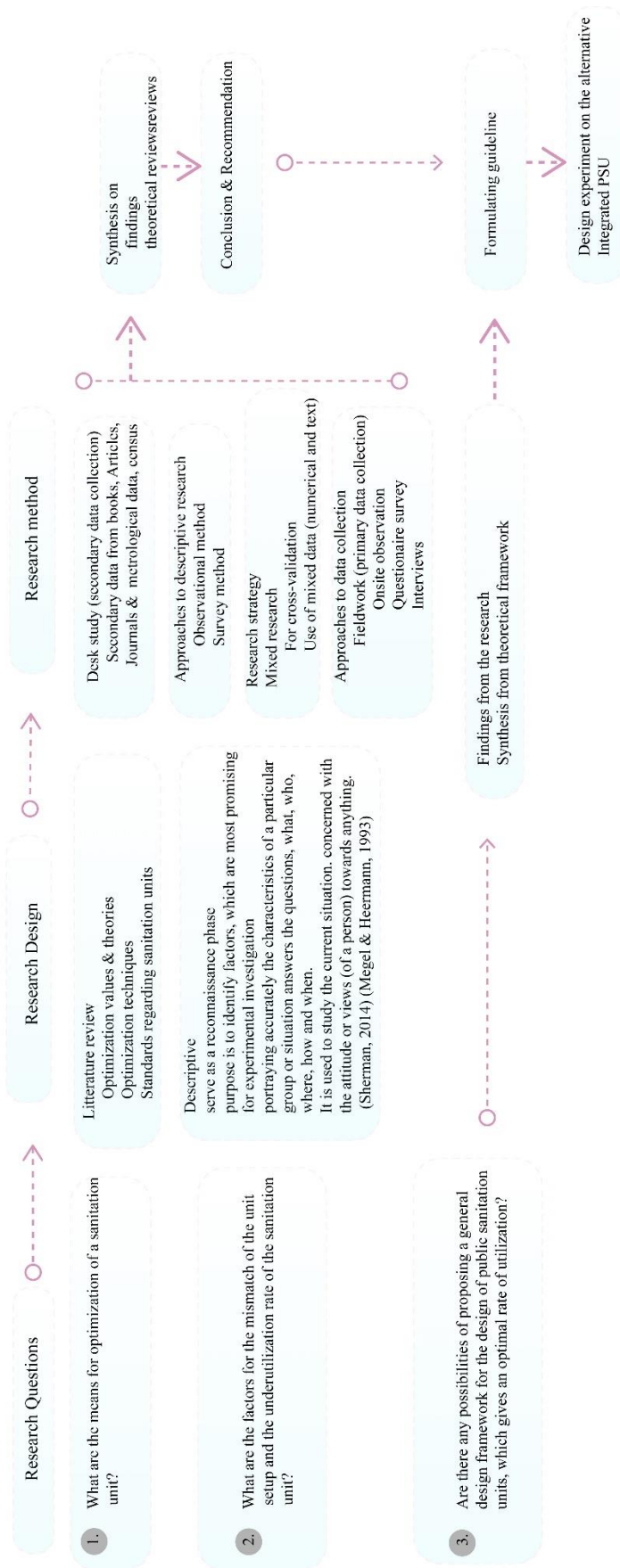


Figure 16 Research design.

4.4. Approaches to data collection

In conduction of this research there are two approaches to data collection, namely, fieldwork (primary data collection) and desk study (secondary data collection). (Naoum, 2007)

Mixed research method

This research have adopted a mixed qualitative and quantitative research method. As Kemper, Springfield and (Teddlie,2003) define mixed methods design as a method that includes both qualitative and quantitative data collection and analysis in parallel form (concurrent mixed method design in which two types of data are collected and analyzed in sequential form). According to (Bazely, 2003), defines the method as the use of mixed data (numerical and text) and alternative tools (statistics and analysis), but apply the same method. It is a type of research in which a researcher uses the qualitative research paradigm for one phase of a study and a quantitative research paradigm for another phase of the study.

Both qualitative and quantitative approaches can be combined because they share the goal of understanding the world in which we live. They share a unified logic, and the same rules of inference apply to both. A combination of both approaches provides a variety of perspectives from which a particular phenomenon can be studied and they share a common commitment to understanding and improving the human condition, a common goal of disseminating knowledge for practical use. Both approaches provide for cross-validation or triangulation – combining two or more theories or sources of data to study the same phenomena in order to gain a more complete understanding of that phenomenon (interdependence of research methods). They also provide for the achievement of complementary results by using the strengths of one method to enhance the other (independence of research methods).” (Sale, Lohfeld and Brazil 2002)

Table 3 Research question and instrumentation

Research question	Type of data	Instrument
1. What are the means of optimization of a sanitation unit?	Qualitative	<ul style="list-style-type: none"> • Literature review
2. What are the factors for the mismatch of the unit setup and the reduced utilization rate of the sanitation unit?	Mixed data	<ul style="list-style-type: none"> • On-site Observation • Questionnaire survey • Interviews
3. Are there any possibilities of proposing a general design framework for the design of public sanitation units, which gives an optimal rate of utilization?	Qualitative data	<ul style="list-style-type: none"> • Literature review • Research findings

4.5. Sources of data and collection methods

Data collection is an integral part of any research effort. Just as important as it is to decide on a research design and strategy, is the choice of specific data-collection methods in conducting the research (Maxwell, 2005).

A. Primary sources of data collection

The primary data sources employed for survey of the public sanitation unit in Wurerber was based on the most common techniques like; on-the-spot observation, Questionnaire survey and structured and unstructured Interview.

B. Secondary Sources of data collection

The secondary data sources have been collected from published and unpublished documents regarding the study variables. From these pre surveyed data from different government offices, pre made maps, population surveys, metrological data etc. were the major sources of secondary data that this paper used.

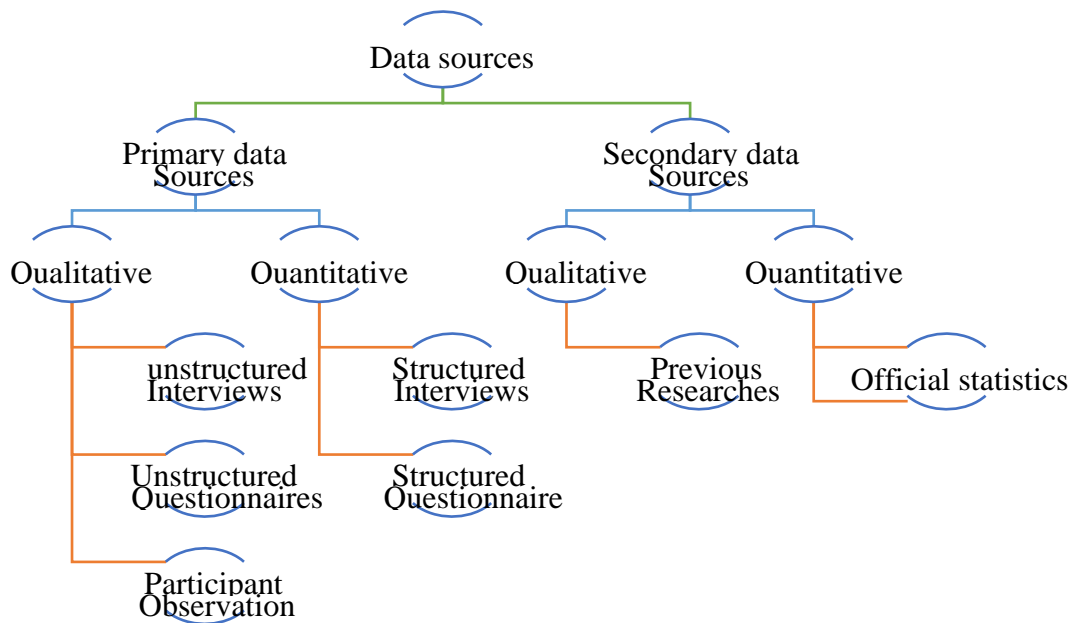


Figure 17 Sources of Data collection.

4.6. Instrumentation

After this decision on the type of data to be collected (mixed data), and have also decided on the research approach (action research), the paper had been in a position to think seriously about the technique for collecting the data. Then the next step was to develop instruments for my data collection. The instruments are the tools used in collecting the data needed in the study. Thus, the way they are developed, validated and analyzed goes a long way in determining the direction of the result that would be obtained in this study.

The instrument used for data collection in this study are onsite observation, questionnaire survey and interviews. On the onsite observation, the researcher directly went to the site in different times and observe existing scenarios deeply. The questionnaire measures the inhabitants' perception and attitude towards the built infrastructure unit. On the interview, the research try to collect qualitative data on gaining insight and context into the topic. The individuals or inhabitants that are the end users by the infrastructure unit in Wurerber had been purposefully sampled. In addition, paying attention to body language and expressions, which may indicate levels of the influence brought about by the unit have been observed.

The paper have tried to examine the demand towards the unit and the service provision deficiencies to determine the efficiency and to take proper measures. The Target groups for the data collection of the built integrated infrastructure unit were;

- Project initiators/developers
- Users/Community
- Project operational management

A. Site visit & Observation

Qualitative research is aimed at gaining a deep understanding of a specific organization or event, rather than a surface description of a large sample of a population. It aims to provide an explicit rendering of the structure, order, and broad patterns found among a group of participants. It is also called ethnomethodology or field research. It generates data about human groups in social settings. Qualitative research lets the meaning emerge from the participants. It is more flexible in that it can adjust to the setting. Concepts, data collection tools, and data collection methods can be adjusted as the research progresses. (Bhawna & Gobind, 2015)

According to (Anis, n.d.), Qualitative research uses observation as the data collection method. Observation is the selection and recording of behaviors of people in their environment. Observation is useful for generating in-depth descriptions of organizations or events, for obtaining information that is otherwise inaccessible, and for conducting research when other methods are inadequate. As cited by (Barbara B., 2000) Marshall and Rossman define observation as "the systematic description of events, behaviors, and artifacts in the social setting chosen for study". Observations enable the researcher to describe existing situations using the five senses, providing a "written photograph" of the situation under study.

Observations can be unstructured, semi-structured or structured. Semi structured and structured involve the development of an observation template. The paper used a direct observation rather than participatory observation technique. Direct observation is distinguished from participant observation in a number of ways. First, a direct observer does not typically try to become a participant in the context. However, the

direct observer does strive to be as unobtrusive as possible so as not to bias the observations. Second, direct observation suggests a more detached perspective. The researcher is watching rather than taking part. Consequently, technology can be a useful part of direct observation. For instance, one can videotape the phenomenon or observe from behind one-way mirrors. Third, direct observation tends to be more focused than participant observation. The researcher is observing certain sampled situations or people rather than trying to become immersed in the entire context. (Crosby, Salazar, Laura F., & DiClemente, 2015)

What do the researcher look for in observation?

- ✓ What is my role in the setting?

The researcher have been a background observer and see the different study parameters; like technical, behavioral, and functional aspects of the project.

- Developing a set of notes away from the observation setting.

Some things to consider - Context:

- What does the site look like? Smell like? Feel like? How is it set up physically?
Take note of this for richness of data
- Drawing and sketching the site or take a photo (ethics permitting) – this had jog the memory later and can be used as part of the data
- Consider the following photo...what do the researcher “see” and how these photos make me feel? Do the researcher have prior knowledge or experience?
How does our background influence the way we see this? (important for reflexivity for my study)

Unstructured observation

First, finding a spot nearby a project site to conduct a 10 minute uninterrupted observation. As part of this activity, noting down what is happening in the specific site location including: (Crosby et al., 2015)

- What is happening within the location?
 - Ambience, atmosphere, environment?
 - Physical characteristics of the setting?
 - How you are feeling and how you think this might influence what you are observing and recording?
- ✓ The aim of the activity is to develop a set of notes that describe the scene as much as possible.

Field notes

Silverman highlights a number of different questions we should consider when conducting observations and writing field notes

1. What are people doing? What are they trying to accomplish?
2. How exactly do they do this?
3. How do people characterize and understand what is going on?
4. What assumptions do they make?
5. Analytic questions: What can be seen going on here? What can be learnt from these notes? Why are they included?
6. What else is happening in the site that is relevant to my research question(s)?
7. How do the researcher feel collecting this data? Comfortable, imposter etc. – how will this affect the data (reflexivity)?

B. Interviews

Unstructured interview

Unstructured interviews can also be conducted at the beginning of any research (also known as exploratory interviews) when the researcher knows little about his/her subject area. Therefore, the researcher had used this type of interview in the beginning of my research, so that it could be helpful for exploring starting ideas towards the study direction. (Nick, 2009)

Semi structured interview

The qualitative research interview seeks to describe and the meanings of central themes in the life world of the subjects. The main task in interviewing is to understand the meaning of what the interviewees say. (Kvale, 2006) Interviews are particularly useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around the topic.

Interviews may be useful as follow-up to certain respondents to questionnaires, e.g., to further investigate their responses. (McNamara, n.d.) From different type of interviews, the researcher conduct an interview of open-ended interview.

- Standardized, open-ended interview - the same open-ended questions are asked to all interviewees; this approach facilitates faster interviews that can be more easily analyzed and compared.
- In semi-structured interviews, the researcher prepares open-ended and closed-ended theme questions but allows participants to share information, feelings, experiences and emotions in conversation exploratory data is gathered. (Oates, 2006; Rogers et al., 2011) as cited by (Gilliland, 2006)

C. Questionnaire survey

The questionnaire has been defined by Franklin and Osborne (1971) as 'an instrument consisting of a series of questions and/or attitude opinion statements designed to elicit responses, which can be converted into measures of the variable under investigation. They can be utilized to measure behavior, beliefs, knowledge, attitudes and attributes. The more stringent and scrupulous the questionnaire design, the more likely that the data collected were useful, and usable.

Prior to the construction of a questionnaire, the researcher must ask some fundamental questions, such as 'what is the purpose of the research?', 'what is the research question to be answered?' and 'is the questionnaire the best method of acquiring this information?' As cited by (Lietz, 2010), (Oppenheim, 1992) asserted that the questionnaire opens a quick and seemingly easy avenue to fact gathering, though this assertion belies the complexity of process involved. Since it focusses on taking the

advantage of seeking the route of the problems in subjective manner, it is very useful for the research data collection.

General considerations while designing a questionnaire:

- Ethical issues had been considered carefully at the outset, and any necessary permission to conduct the research should be obtained at this stage. It is useful to challenge the notion that the questionnaire is a benign instrument in the ethical context. (Anon, 2012)
- Questions should be simply worded, generally less than 20 words in length and unambiguous. (Oppenheim 1992) as cited by (Lietz, 2010)
- Questions should be phrased for the lowest, rather than the average, educational level of the target population (Barker 1994) as cited by (Lietz, 2010), and contain words that virtually all respondents understand.
- Consideration should be given to whether the words chosen have an alternative meaning, and the researcher should beware of implicit assumptions in question wording (McColl 1993) as cited by (Lietz, 2010)
- Hypothetical questions are notoriously difficult to answer, and often do not yield reliable results (Sinclair 1975) as cited by (Lietz, 2010). Questions should generally be worded positively, and care exercised to avoid 'leading' questions, where the wording suggests the appropriate answer.

Development of the questionnaire

The questionnaire was designed and developed by the Researcher. It was labeled for inhabitants Attitude towards the built infrastructure unit. This questionnaire had two divisions: Division A and Division B. Division A seeks for demographic information from the students such as Name, Sex, Age, School, and Class. Division B that seeks to know issues relating to the extent of the efficiency of the infrastructure unit. The questionnaire was raised against a five— point Likert scale except in some questions, which requires the users to rate their response. Inhabitants will be required to respond by placing a tick at the appropriate column.

Question types

The research have used closed ended questions for my questionnaire. Open questions allow the respondent to formulate their own response, in their own words, and therefore define their own frame of reference. However, they are more time consuming to answer, are believed to lower the response rate and require content analysis by the researcher, assuming they can translate the handwriting!

Scale

In designing a questionnaire seeking to elicit attitudes or feelings, separate sections incorporating attitude scales and/or semantic differentials are often included. Attitude scales, such as those devised by Likert scale. (Joshi, Kale, Chandel, & Pal, 2015) It usually take the form of a series of positive and negative statements, to which the respondent indicates their response by degree, on a continuum containing five to seven response categories. Each response can then be scored by ascribing it a value; dependent upon the degree of agreement/disagreement with the statement, and a total sum for the scale is calculated for each respondent. The researcher then interprets this cumulative total during analysis.

Procedure

The researcher had first pursue permission from the inhabitants that were sampled for the study to obtain an appropriate day and time for the administration of the questionnaire & experimentation. The researcher then physically went to the specific site (Wurerber) to administer these questionnaires provided for the stakeholders like the sampled inhabitants, project initiators, project builders and government authorities. On administering the assessment, the researcher explained to the data providers the procedure for filling the questionnaire. All the test items were collected on site and home-to-home survey.

4.7. Sample and sample size

Sampling

According to the book *Research design* by (P. Leavy, 2017), sampling is the process of selecting a number of individual cases from a larger population. The first thing to do is to determine the elements in the study. An element is the kind of person, group, or nonliving item in which you are interested (sometimes the word *unit* or *case* is used). Therefore, in my research the element is the individuals that use the Infrastructure unit. Next, the population should be identified. A population is a group of elements about which the researcher might later make claims. So the population is the community of Wurerber village. Once it is identified the element you are interested in and the population, that need to determine the study population (sometimes called the *sampling frame*). The study population is the group of elements from which the research actually draw my sample. The researcher then draw a sample from the study population. A sample is the number of individual cases that the research ultimately draw and from which/whom the data will be generated. (P. Leavy, 2017)

The issue of determining sample size is an important aspect of a research design. Because a primary objective (for making valid inference back to the population from the sample) is to ‘minimize both alpha error (finding a difference that does not actually exist in the population) and beta error (failing to find a difference that actually exists in the population)’ (Hashim, 2010)

One method of determining sample size is to specify margins of error for the items that are regarded as most vital to the survey. An estimation of the sample size needed is first made separately for each of these important items’ (Cochran, 1977).

It is important to remember that the sample size consideration relates to usable data sets and not the size of the sample approached to elicit data (responses). Hence, the results of sample size calculations must be modified to accommodate response rates in determining the size of sample to be approached for data (as indicated next).

For populations that are large, (Cochran, 1975) developed the Equation 1 to yield a representative sample for proportions.(Singh & Masuku, 2014)

$$n_0 = \frac{Z^2 pq}{e^2} \quad \text{Equation 1 sample size formula}$$

Where n_0 is the sample size. Z^2 is the abscissa of the normal curve that cut off an area A at the tails ($1 - A$ equals the desired confidence level, e.g., 95%) 1 , e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is $1-p$. The value for Z is found in statistical tables, which contain the area under the normal curve.(Singh & Masuku, 2014)

- Based on the (Cochran, 1975) formula, because of the population number range the sample size for the research in Wurerber public sanitation unit is calculated for a $\pm 7\%$ Precision Levels Where Confidence Level is 95% and $P=0.8$ and $q=1-p=0.2$.

$$n_0 = \frac{(1.96)^2(0.8)(0.2)}{(0.07)^2} \quad \text{Equation 2 sample size calculation for the research}$$

$$n_0 = 125 \text{ samples}$$

If Cochran's initial formula results in a sample size, which is more than 5% of the population, then a correction should be applied to arrive at the final sample size.

$$n_f = \frac{n_s}{(1 + n_s/P)} \quad \text{Equation 3 final sample size formula}$$

where:

n_f = final sample size

P = size of the population

Hence, the final sample size calculated as:

$$n_f = \frac{125}{(1+125/2621)} \quad \text{Equation 4 final sample size}$$

$n_f = 120$ samples have been used for this research

Probability Sampling

This thesis have adopted Probability sampling as a sampling strategy which relies on probability theory and involves the use of any strategy in which samples are selected in a way that every element in the population has a known and nonzero chance of being selected. This means that the chance that each element in the population will be included in the sample can be statistically determined, and the chance of inclusion, no matter how small, will be a number above zero. Each element has some chance of inclusion. (Singh & Masuku, 2014) From different kinds of probability sampling like simple random sampling, systematic sampling, cluster sampling and stratified random sampling, the researcher have selected the stratified random sampling for this research.

Stratified Random Sampling

This is a sampling strategy in which elements in the study population are divided into two or more groups based on a shared characteristic (these groups are called *strata*). (Singh & Masuku, 2014) Then the next step was conducting simple random sampling. In this research different strata's like gender (male, female and Trans gender), age zone (children, adult and elderly), physical condition (fit, challenged) etc. are used.

4.8. The Course of the Research Process

The Public sanitation unit, which have been constructed in Wurerber village, is chosen for the research. On this research it has been performed an on-the-spot assessment by making an observation of its use and the behavior of the users. Photographic records have been performed and a simplified qualitative and quantitative assessment for the following categories performed: geographical, technical, functional, behavioral and managerial quality. Next, the research attempt at finding an answer to the following

question: What are the topological, typological aspects of the sanitation unit? What are the factors for the mismatch of the unit setup and the rate of utilization of the sanitation unit? Are there any possibilities of proposing a general design framework for the design of public sanitation units, which gives an optimal rate of utilization? In selected case, more detailed assessments were performed, for example, by applying the technique of an unstructured interview in the form of a casual, spontaneous conversation. At each time, there was an attempt to specify the correctness of the investments, program assumptions and the final effect that was produced through the prism of meeting the user needs. As the open-access space within a city, district, a settlement or a commune serves, as matter of principle, all users (both the residents and “visitors”) then a specially designed and developed public zone, built in the form of square, park etc. and offering a new quality, should serve all groups of users. Due to that fact, in the research process the focus was directed towards that very aspect, towards the needs of various user groups: little children, mothers with children, youth, adults, the elderly, the disabled, couples, multi-person groups etc.

Chapter Five: Result & Discussion

In this chapter, the researcher have tried to analyze the collected data from Onsite observation, Questionnaire survey and Interview with project initiators. After the analysis for the collected data discussion of the result will be presented.

5.1. Onsite observation data result & discussion

As it is discussed on the introduction chapter, one of the approach to representing the building layout design space is to decompose the problem into two parts: topology and geometry. Topology refers to logical relationships between layout components. Geometry refers to the position and size of each component in the layout. Topological decisions define constraints for the geometric design space. (Medjdoub & Yannou, 2001) In this subtitle, the topological and geometrical aspects of the sanitation unit are analyzed. First, the topology of the sanitation unit is analyzed based on the catchment centrality, connectivity & visibility. Then the typological analysis of the sanitation unit is analyzed based on the geometry of the unit with sanitation culture of the society, functional arrangement of the sanitation unit and ecological analysis of the sanitation unit.

A. Topological analysis of the sanitation unit

According to (Meng, Fu, Farmani, Sweetapple, & Butler, 2018), there are six key topological attributes of water distribution systems (WDSs); these are connectivity, efficiency, centrality, diversity, robustness and modularity. Results show that only certain aspects of resilience performance, i.e. spatial and temporal scales of failure impacts, are strongly influenced by some (not all) topological attributes, i.e. network connectivity, efficiency, modularity and centrality. (Meng et al., 2018) From these attributes, the researcher have selected to study the connectivity and centrality for this study because of time constraint. From different types of centrality, also this research focused on closeness centrality. Because Closeness centrality measures how short, the shortest paths are from the PSU to all nodes. It is usually expressed as the normalized inverse of the sum of the topological distances. This sum is also known as the farness of the nodes.

i. Geographical location

The sanitation unit is located in Wurerber Kebele with a unique name Amora Meda, with a latitude of 8°10'17.82"N and longitude of 37°51'45.57"E. (Google earth pro)

ii. Catchment centrality

As it is discussed on the literature review, (Paolo Crucitti, etal 2005), the consequence of events depend on the topological characteristics of cities, which are the result of the particular growth process and geography of a place. Centrality is relevant for various spatial factors affecting human life and behaviors in cities. In the field observation from the five measures of centrality closeness of the unit from their living place is analyzed. Centrality measures serve to quantify that in a network some nodes are more important (central) than others. As described in the table below, the sanitation unit is located near the following areas, which are in 1 Kilo Meter (km) radius; these are the possible users of the sanitation unit. Amora meda 1, which is 0.2 km from the sanitation unit, Nuramba that is 1 km from the sanitation unit, Chifingra 1 that is 0.8 km from the sanitation unit, Yejusebe 1 that is 0.9 km from the sanitation unit. In addition, the places like the mosque, health care and the workers from both the investor farms are the possible users.

Table 4 Catchment centrality

Village or Place	Distance from the sanitation unit(km)	Remark
Amorameda 1	0.2	<1K.m, possible users
Amorameda 2	1.2	>1K.m
Nuramba	1	<1K.m, possible users
Chifingra 1	0.8	<1K.m, possible users
Chifingra 2	1.6	>1K.m
Yejusebe 1	0.9	<1K.m, possible users
Yejusebe 2	1.8	>1K.m

Yefeterek wodro	2.2	>1K.m
Mosque(M)	0.2	<1K.m, possible users
Health care(H)	0.15	<1K.m, possible users
Church	1.8	>1K.m
Flower farm	1.3	>1K.m
Investor farm land(I.F.L) 1	0.1	<1K.m, possible users
Investor farm land (I.F.L) 2	0.5	<1K.m, possible users

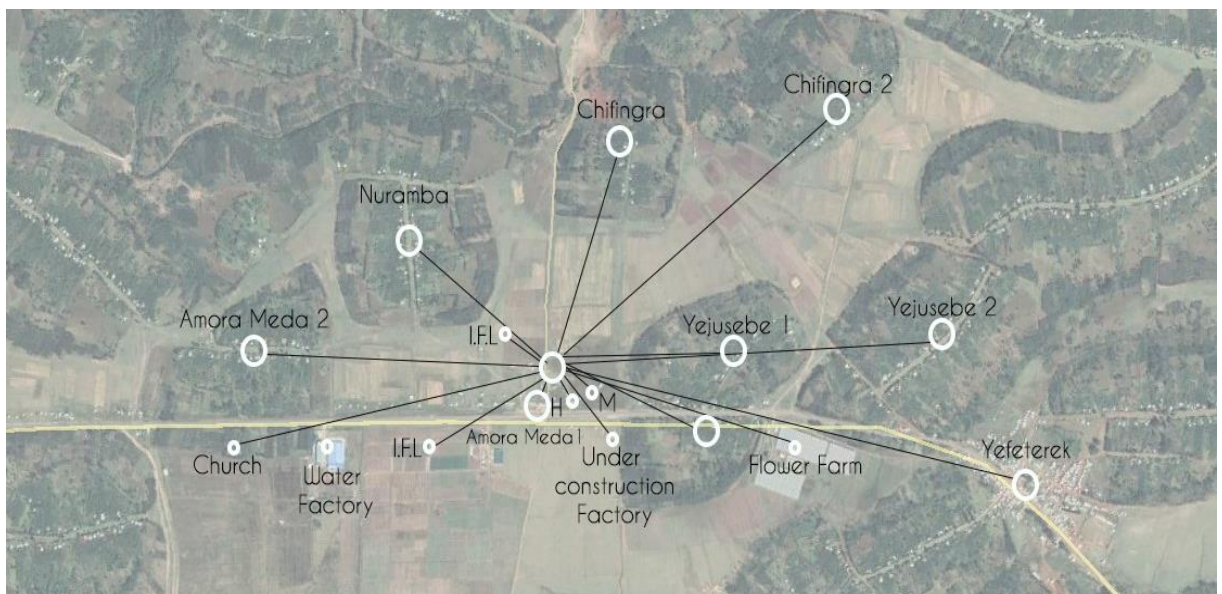


Figure 18 Catchment Centrality

iii. Connectivity

Visual connection defines as contact from the sense of sight to the physical environments (Peponis et al., 1998, Batty, 2004, Padgitt and Hund, 2012) as cited by (Saiful, Wan, & Said, 2012). In relation to visual connection, Marshall and Garrick (2010) use visual representation captured from street environment that can facilitate human use the space as cited by (Saiful et al., 2012). Lwin and Murayama (2011) view visualization as a parameter to determine the most eco-friendly environment for a pedestrian in their route choice to a destination. In environmental psychology study,

Padgitt and Hund (2012) use spatial visualization to get the quality of direction of human navigation. Visual connection, spatial visualization, visual representation, and visibility are seen to explain connectivity between human and space. Therefore, they used to become parameters in measuring connectivity. (Saiful et al., 2012)

A. Spatial connectivity

Connectivity is the extent flows of passengers or freight from a node can reach other nodes either directly (direct connection) or indirectly through another node(s). Connectivity remains strongly dependent on transportation networks that provide the physical capability to reach places, which can be done through a single or a series of modes. (Jean-Paul Rodrigue, Claude Comtois, 2017)

Connectivity is strongly dependent on transportation networks that provide the physical capability to reach places, which can be done through a single or a series of modes. (Jean-Paul Rodrigue, Claude Comtois, 2017)

As it can be seen in the next picture, the sanitation unit is connected to the foot bitten path, which connects the main road to the neighboring villages. The means to get to the sanitation unit is through walking and also cars can get in the summer time, but in the winter time the area becomes more squelchy and hard to get in to even on walking. Therefore, what it have been seen is there is no clear way to the unit. This creates low connectivity of the unit with the surrounding spaces.



Figure 19 Ways to get into the PSU. Photo by the author. May 2019.

B. Visual connectivity (Visibility)

As it can be seen in the following view shed map, which is developed by google earth pro view shed tool, the green colored areas are the more advantaged areas in terms of the visibility of sanitation unit. In addition, it is more visible for the areas above the main road. Based on this the researcher have tried to observe the sanitation usage of the inhabitants from the grey and the green areas. The ones that use the sanitation unit frequently are the green colored areas on the map below.

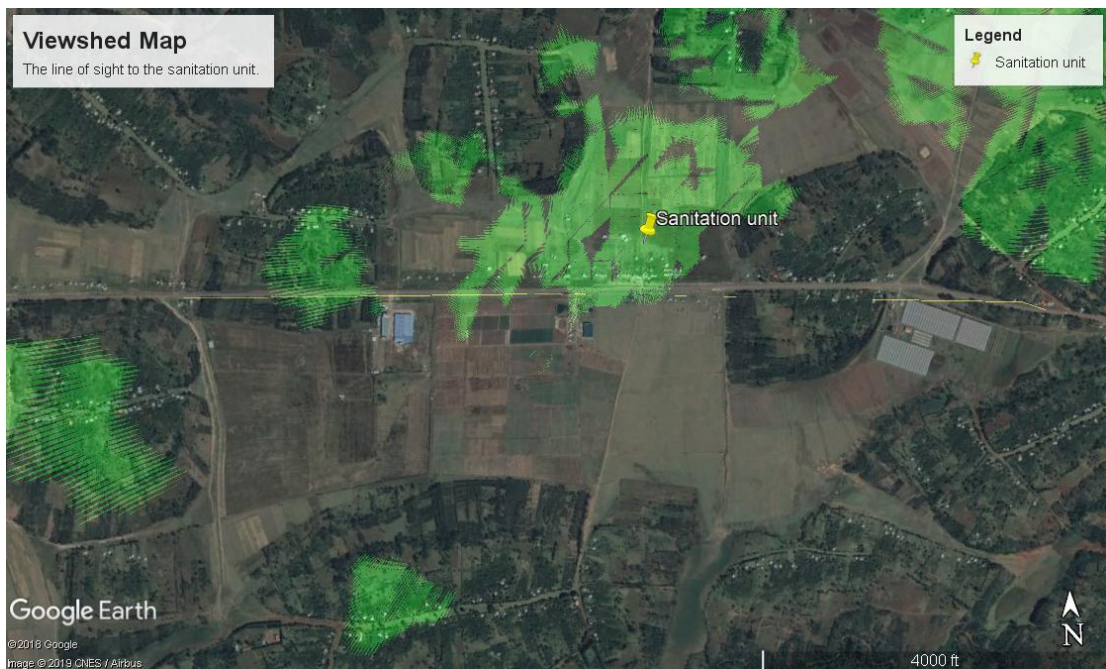


Figure 20 View shed map (Visibility); Source: Google earth



Figure 21 Views towards the unit. Photo by the author, May 2019.



Discussion on Topological findings

One of the objectives of this thesis was to explore the topological features of the existing sanitation unit in Wurerber, which is constructed by the project of IN3. The thesis have tried to study the features regarding catchment centrality and connectivity issues.

As it is studied on the catchment centrality section in the theoretical framework, (Paolo Crucitti et al, 2005), the consequence of events depends on the topological characteristics of cities, which are the result of the particular growth process and geography of a place. Centrality is relevant for various spatial factors affecting human life and behaviors in cities. In the field observation from the five measures of centrality closeness of the unit from their living place is analyzed. It is found that the catchment centrality affects the usage of the sanitation unit. The sites, which are in 1km radius, are more favorable and these are the most frequent users of the unit. Therefore the location of the sanitation unit must favor all as much as possible.

The other factor, which the research try to find out, was on the topological features of the sanitation unit, one of which is the connectivity of the unit to the surrounding. Here both types of connectivity are studied and analyzed, the spatial connectivity and the visual connectivity. On the spatial connectivity, what the thesis has found is that there is no clear way to the unit. This creates low connectivity of the unit with the surrounding spaces. The vehicles try to get into the unit through parking on the street. Since there is no favorable entryway to the unit. When we see the visual connectivity or visibility of the unit, as it can be seen in figure 9 on the view shade map, which is produced from google earth, the picture, have two colors the grey and the green colors. The green color shows the places where the unit is visible. And when the data is related with the questionnaire survey the green areas above the main road are found to be the most frequent users of the sanitation unit. What it can be concluded from this is the more the visible the unit is the more the user it will have.

B. Typological analysis of the sanitation unit

Typology in architecture has been defined as creating archive of the certain types related to architecture styles reduced to their elementary geometrical nature or the search effort of the combination possibilities of the architectural elements to classify the types which are the architectural forms. (Ayyildiz, Ertürk, Durak, & Dülger, 2017)

The relation with the built environment created with the society's owned culture and the location where the built environment is through the historical layers. Cultural and natural values owned by the city, shape the city identity. To have a city identity, it is necessary to provide the continuity of these values and to protect moral and material values which transfer messages of city's past to its future. (Ayyildiz et al., 2017)

i. Sanitation culture of the society

Showering culture

As observed on site and from the pilot survey, it is found that the showering culture differs in religion, culture and age group. In Muslim religion if a man washes his body on some place the woman could not be allowed to wash on the public place. Both male & females prefer to have a fixed partition rather than open one. However, because the sanitation unit has no partition, they try to manage the unisex issues by just giving a time interval for male and females and giving the key for a single user at a time. In addition, on age groups the elderly and the young's did not use it because of the reasons of cost, appliance reachability for the young's and the preference to wash on private rather than on public for the elderlies.

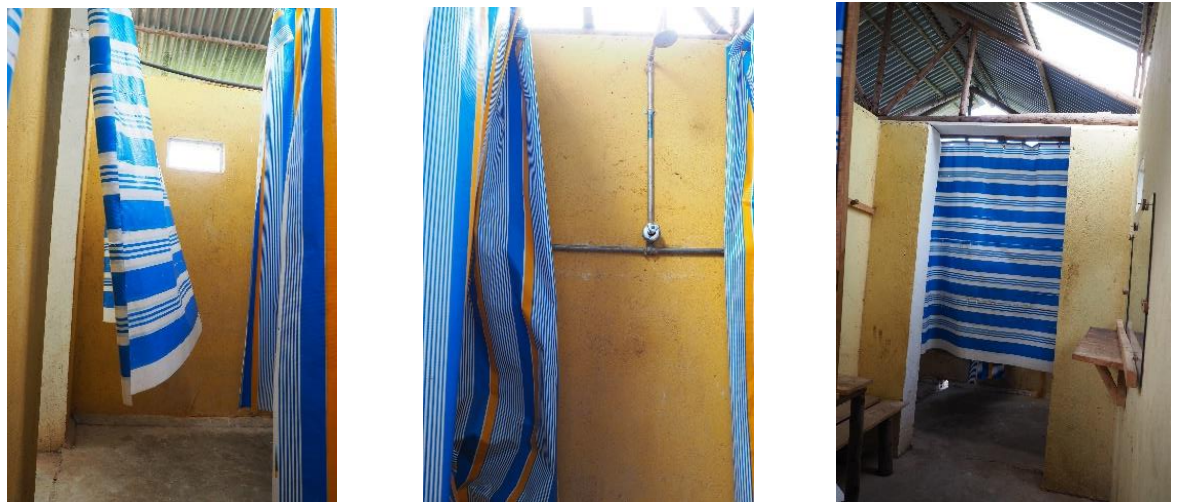


Figure 22 Public sanitation unit (PSU) Shower unit; Photo by the author, June 2019

Laundry culture

In most of Ethiopian rural areas, the trend of showering and laundry is the same. The inhabitants in the rural areas use the raw water from the river nearby to wash their body and their clothes. The children and the elderly use a shower first by collecting the water with a jar or any available collection tanks and wash on the river or taking to their home, but most of the adults prefer washing and swimming directly in the river.



Figure 23 Wurerber Laundry culture (on river); Photo by the author, June 2019



Figure 24 Water fetching from ground water; Photo by the author, June 2019

The same rural culture works for Wurerber Kebele, since the Kebele is located in one of Ethiopian rural areas and the existence of a river nearby. The peoples live there use the raw river water for washing and cleaning. Because of different reasons that will be discussed in the data analysis and findings chapter, most of the inhabitants are continuing using the river to fulfill their sanitary needs. Some of the inhabitants who can afford to buy a clean tap water; they buy with a jar and use it for their needs. Others use the ground well water in their home.

What it have been observed on site is in Wurerber the inhabitants need an extroverted space for washing their clothes or anything regarding cleaning, but this culture has not been considered in the design of the Sanitation unit. In addition, the design of the laundry had problems not only the organization of space but also in terms of the size for washing, laundry material and waste water line of way.

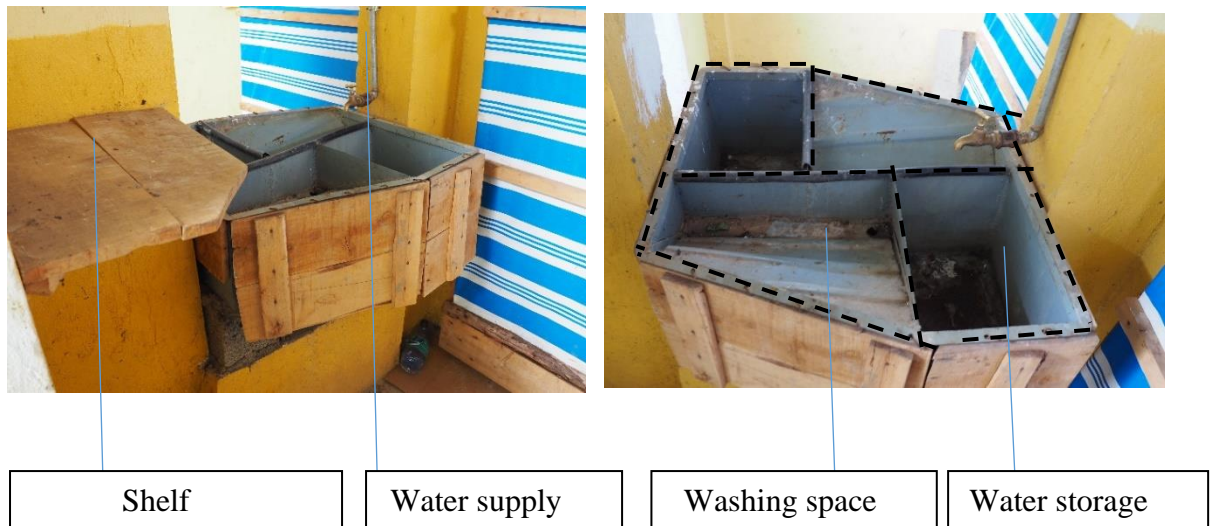


Figure 25 PSU laundry unit; Photo by the author, June 2019

The laundry space have a small size and the design of the unit by itself is not favorable for washing since it is made of sharp materials, which can censor the clothes.

ii. Functional arrangement & space usage frequency of the sanitation unit

A. Functional arrangement

The overall built up space is 80 Sq.m. From these 15 Sq.m is given for showering space, for changing and waiting space 20 Sq.m, for laundry 10 Sq.m and the rest 25 Sq.m for circulation.

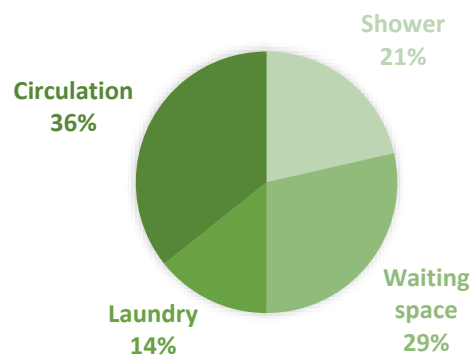


Figure 26 Area of PSU Functions

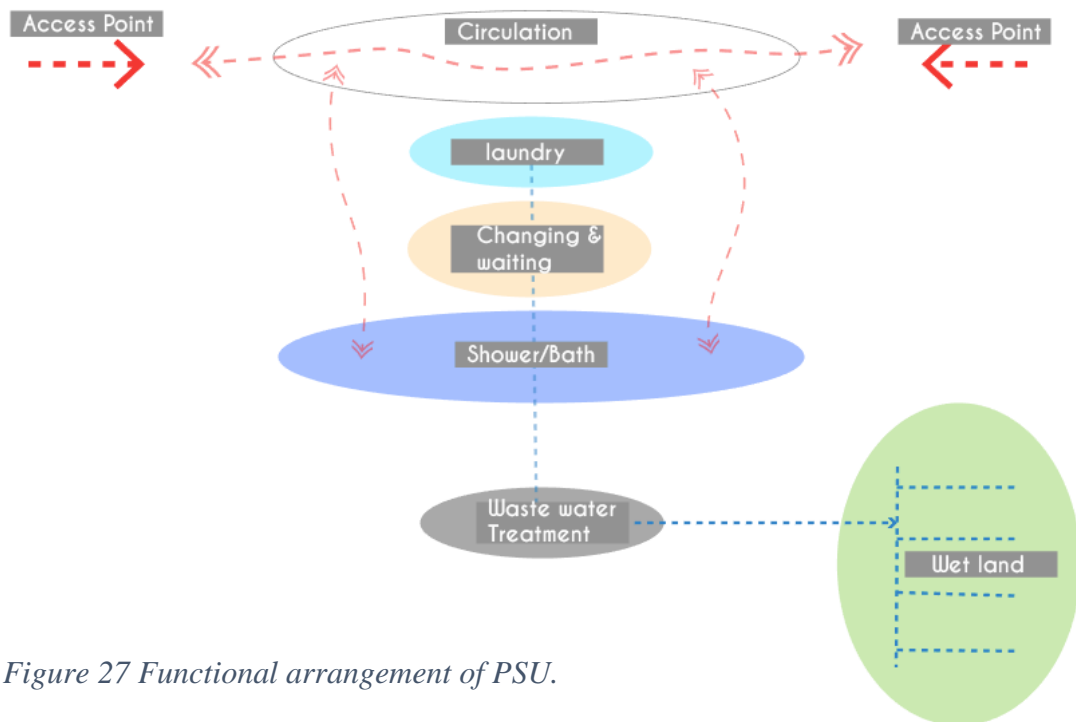


Figure 27 Functional arrangement of PSU.

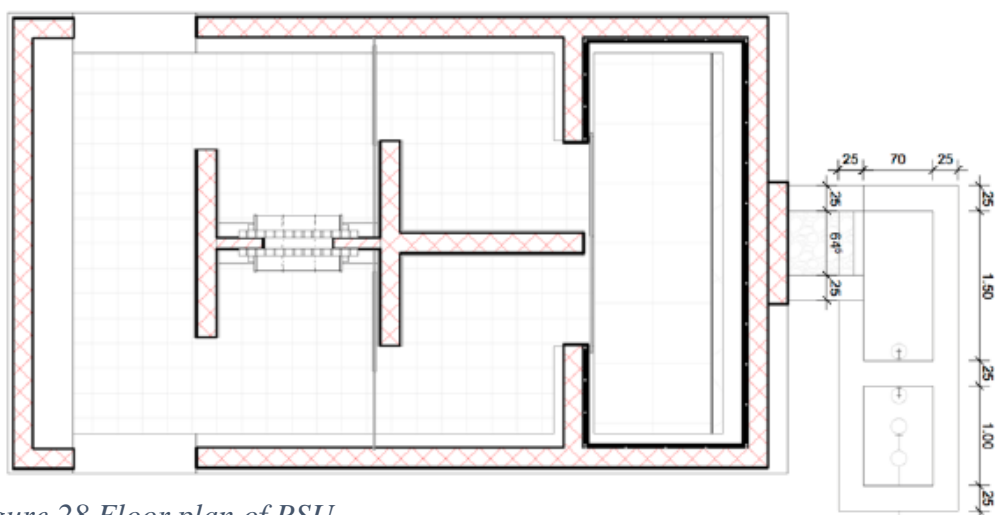


Figure 28 Floor plan of PSU



Figure 29 PSU Interior views; Photo by the author, June 2019

B. Space usage frequency

In 3 days the field observation prior to questionnaire data collection, the space usage frequency has been observed and recorded. The days are chosen based on the pilot survey interviews, which was conducted before starting the research, and found that the usage becomes high in Friday and Sunday. Therefore, the researcher have chosen the observation to be in one ordinary day and on these two selected days. Therefore, the observation takes place on Thursday, Friday and Sunday. As it can be seen in the following chart, there are idle spaces that no one is using them like the laundry and waiting space. Then the pattern of usage is traced and shown on the figure below.

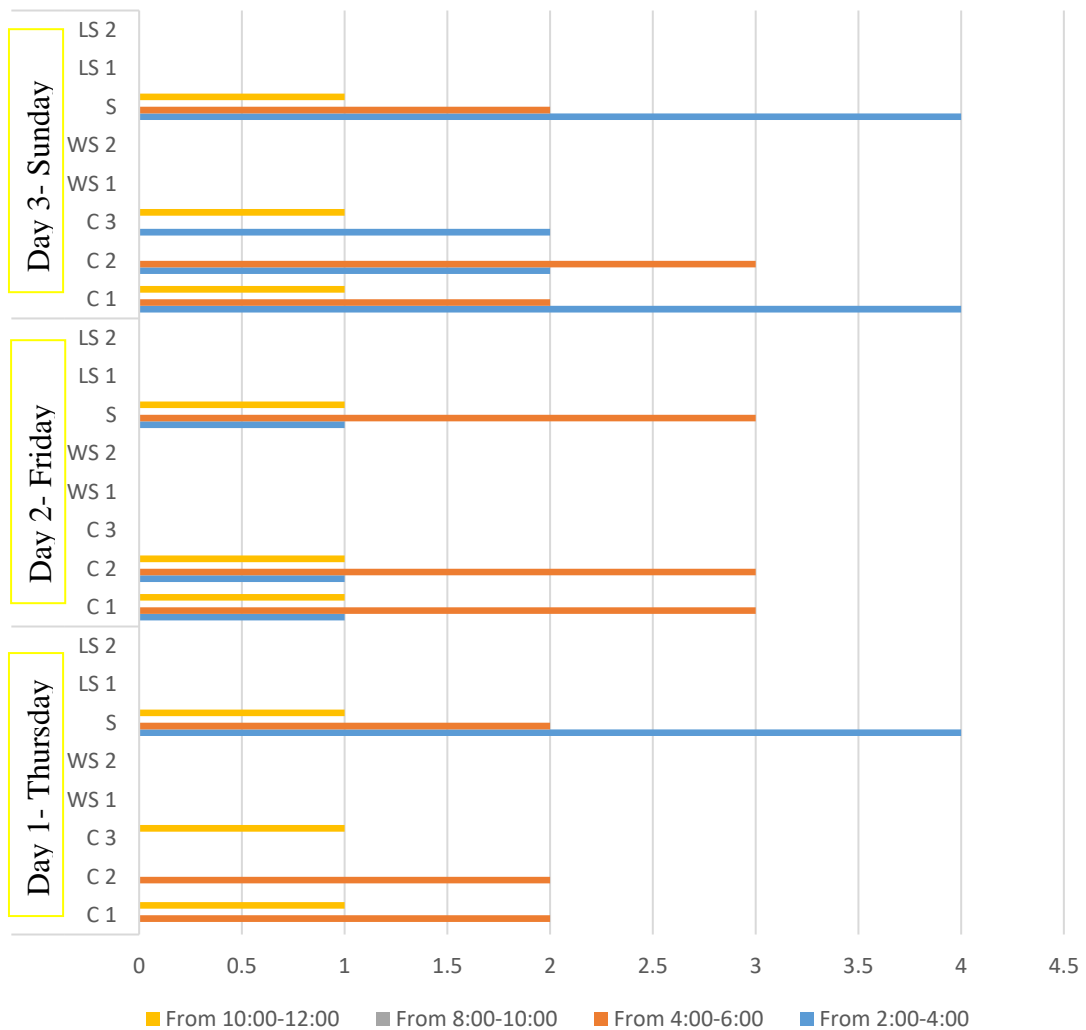


Figure 30 Space usage frequency chart

iii. Ecological aspects of the sanitation unit

Water resource supply and consumption

It is studied and proved that water resource is scarce and needs to be conserved. As it is discussed on the introduction chapter Wurerber is one of the 13 pilot sites chosen for the rural urbanization projects in GTP 2. Therefore, it is supposed to be a pilot also on water resource conservation. But the sanitation unit is trying to fulfill all the water demand from the municipality supply line. The supply is inconsistent as it is observed on site and analyzed from the questionnaire survey, and also it takes the water from the main drinking line rather than using an alternative water source for the sanitation purpose.

As it has been seen in the onsite observation, the consumption for the shower per individuals is high and there is a wastage of water when the users are washing. The awareness of the community is low regarding water conservation. Moreover, the other problem observed is every user pays for the whole package 5-7 birr not for what he has consumed water. This is also the other problem that can be seen in the water wastage.

Wastewater treatment

The wastewater treatment follows different stages. First, the raw wastewater will be collected in the settlement tank/ Grit chamber. Here settlement of solids and restraining of floating sludge will take place. Then the water will go through the next chamber, which is called intermittent feeder, here it feeds the plant with the needed volume of grey water and it is

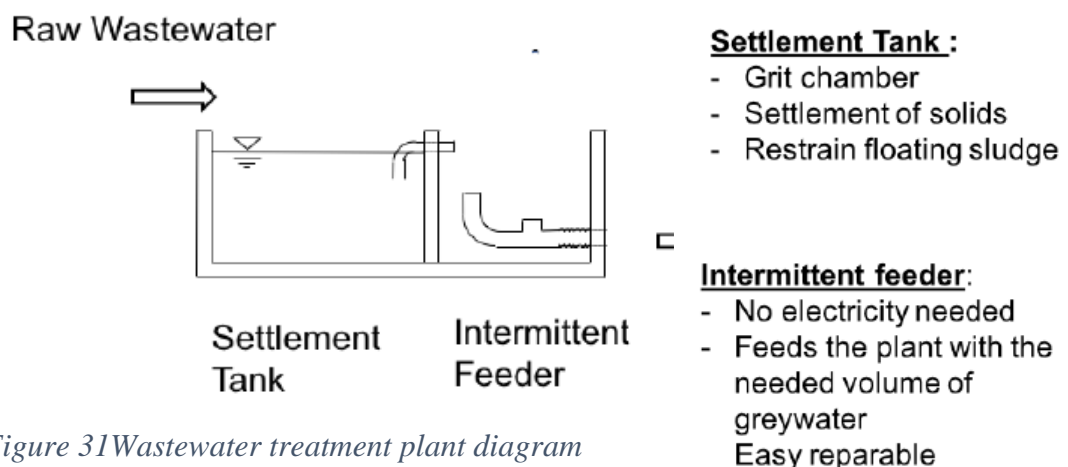


Figure 31 Wastewater treatment plant diagram

easily repairable. The final stage is feeding the grey water into the wet land pipes. Then the treated wastewater will be segregated in to the bed of rubble coarse and fine aggregate through the perforated pipes and then it will join the ground water.

The problem that is reported by the management body and observed on site survey, the settlement tank is very small to hold even the underused sanitation wastewater. And as the researcher get the data from the manager, on every Wednesday's the manager try to clean the filled settlement tank by taking the waste water using buckets and flush it on nearby surface. It smells bad and he is suffering from this problem. From this, we can see that there is a problem not only on size but also on the wastewater treatment system.



Figure 32wastewater treatment tanks; Photo by the author, June 2019

Discussion on Typological findings

The other objective of this thesis was to explore the geometrical features of the existing sanitation unit in Wurerber and try to observe what these effects are. Since typology is finding the property or characteristics of the unit concerning the culture, space and the ecological features of the unit as discussed by Christoph Elsener, the study focused on these issues. The culture of the shower taking of Wurerber Kebele inhabitants is either open on the river or shade in their house. Different peoples have different preferences, what has been observed is that the women, the elderly and the young's prefer to wash in their home but the adults prefer the river. The culture of the society for washing clothes is mostly on the river. As observed on site, it is found that the showering culture

differs in religion, culture and age group. In the Muslim religion, if a man washes, his body on same place the woman could not be allowed to wash on that place. Both male & females prefer to have a fixed partition rather than open one. However, what has been observed on the built sanitation unit is there is no unisex space, which is designed for male users and female users separately. The partition material by itself is not comfortable for users since it is not fixed. Therefore, what it have been observed is that all things are the contributing factors for the underutilization of the Public sanitation unit.

In most of the Ethiopian rural areas, the inhabitants use the raw water from the river nearby to wash their body and their clothes. Since there is a river nearby, the peoples live in Wurerber use the raw river water for cleaning their clothes and washing their body. The inhabitants prefer the washing their clothes in an outdoor environment, not in their home or enclosed space. However, this culture has not been considered in the design of the Sanitation unit. Besides, the design of the laundry had problems not only the organization of space but also in terms of the size for washing, laundry material and wastewater line of way. That is why they prefer washing on the river rather than in the built sanitation unit still.

Only the shower and the circulation space are the only space that is utilized most. For the data collection method in studying the spatial usage frequency of the spaces, the researcher made a 3 days onsite observation and recording. The survey was chosen the observation to be in one ordinary day and on two selected days based on the pilot survey interview. So the observation takes place on Thursday, Friday and Sunday. Most of the Muslims use the shower on Friday and most Christians use a shower on Sunday in the sanitation unit. Nearly 43% of the unit area is given for the waiting room and laundry, but when we see the frequency of the usage of this spaces they are not used by most of the users, from what it can be observed is that these spaces should better be placed outside the unit, because of the space placement preference of this spaces.

The other basic thing, which was analyzed from the typological feature of PSU on-site observation, was the ecological feature of the unit. The sanitation unit is trying to fulfill all the water demand from the municipality supply line. The supply is inconsistent and taking the clean water from the drinking water. Wurerber PSU should use alternate water source like groundwater, treated greywater or rainwater harvesting. What the

researcher have observed is that there are more than three water-bottling factories in Wurerber; this shows us the site has a rich groundwater resource. If this was applied to the unit, it uses its off-grid water supply system and the cost requested for the service will be minimized.

The initial idea behind the wastewater treatment and diffusion system was excellent, but the affluent and the usage was not been studied well, the settlement tank became full every week and that is why the PSU manager is suffering to dislodge the wastewater from the settlement tank and flush it on the surface. This makes the unit not acting based on the initial idea. This creates the smell and there is no design for the collected waste from the settlement tank to go.

5.2. Questionnaire survey data result & discussion

A. Analysis of volunteer respondents

In this research, the researcher have planned to collect data based on the proximity of the respondents to the IIU and on the agreement for providing data voluntarily. Based on this the researcher have divided my total number of respondents in to two neighbor kebele's, namely Wurerber and Yefeterek Wodro. As it can be seen in the following table, two villages are selected for each Kebele namely Amora meda and Nuramba for Wurerber and Chifin girar and yejusebe for Yefeterek Wodro.

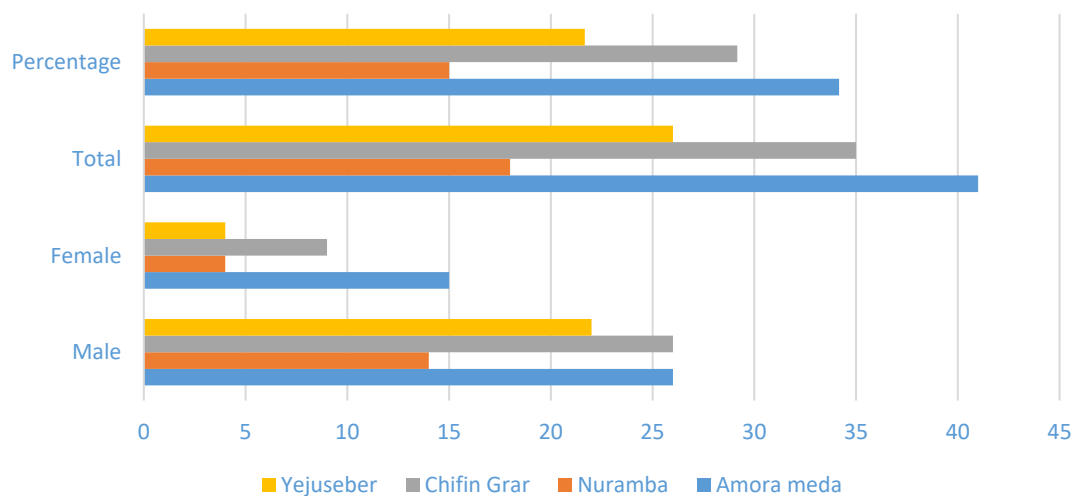


Figure 33 Volunteer respondents chart

Table 5 Total number of volunteer respondents

Total number of volunteer respondents				
Wurerber				
	Male	Female	Total	Percentage
Amora meda	26	15	41	34.2
Nuramba	14	4	18	15.0
Yefeterek wodro				
Chifin Garar	26	9	35	29.2
Yejuseber	22	4	26	21.7
Total			120	100%

Age group of the respondents

As shown in the chart below, the researcher have tried to collect data from all age groups as much as possible. Since the age group influences the usage of the IIU, it is necessary for my research to gather information regarding this stratum.

Religion of the respondents

As it can be seen from the religion data table below majority of the inhabitants in Cheha Woreda are Muslims, the second one is orthodox, and the rest one are Protestants. The percentage of the users vary in the shower usage. Even if the protestant population is low in number, and the usage frequency is greater than the Muslims & Orthodox users. However, in number the majority of the users are the Muslims and next the orthodox.

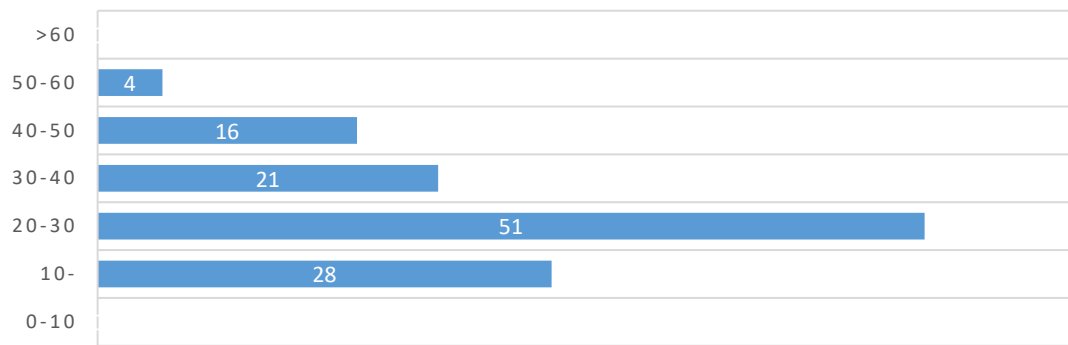


Figure 34 Respondents Age group.

Table 6 Religion of respondents

Religion	Number	Percentage
Orthodox	48	40%
Muslim	59	50%
Protestant	13	10%
Total	120	

Marital status of the respondents

As shown below on the table the percentage of the married is slightly larger than the percentage of the bachelors. However, they are seemingly proportional.

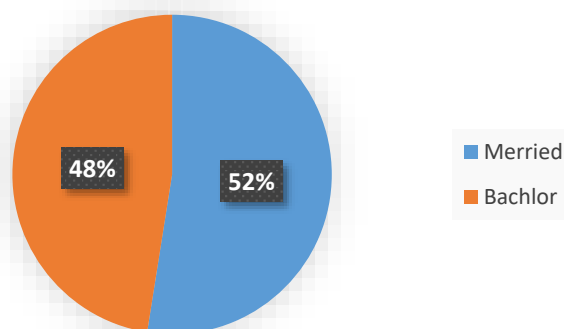


Figure 35 Marital status of the respondents.

B. Analysis of the demand survey with Demographic data

Demand with respect to Age group

As it can be seen in the table below the usage of the PSU for shower is 38% from the total respondents but for the laundry it reduces to 10 % of usage. From the data, it has been observed that, the demand for the sanitation unit differ in different age groups. The majority of the users are from 30-40 years age groups, and the least ones to use the integrated infrastructure sanitation unit are from less than 10 and greater than 60 years age groups.

Table 7 Shower and Laundry overall usage

Shower usage	Response	total	%
	yes	46	38
	no	55	47
	I don't know	19	15
	Total	120	100

Laundry usage	Response	Total	%
	yes	12	10
	no	88	74.2
	I don't know	19	15.8
	Total	120	100

From the following table we can see that the majority of the population of the community are in the range of young to adults. From the age group 10-20 years from the total of 28 respondents 82% of them use the shower in the infrastructure unit. From the age group 20-30 years from the 51 respondents 86% of them use the shower in the infrastructure unit. And from the age group 30-40 years from the total of 21 respondents 57% of them use the shower in the infrastructure unit. From the age group 40-50 years from the 16 respondents 44% of them use the shower in the infrastructure

unit. Finally, from the age group 50-60 years from the 4 respondents none of them use the shower in the infrastructure unit. The usage of the unit decreases when the age group becomes higher.

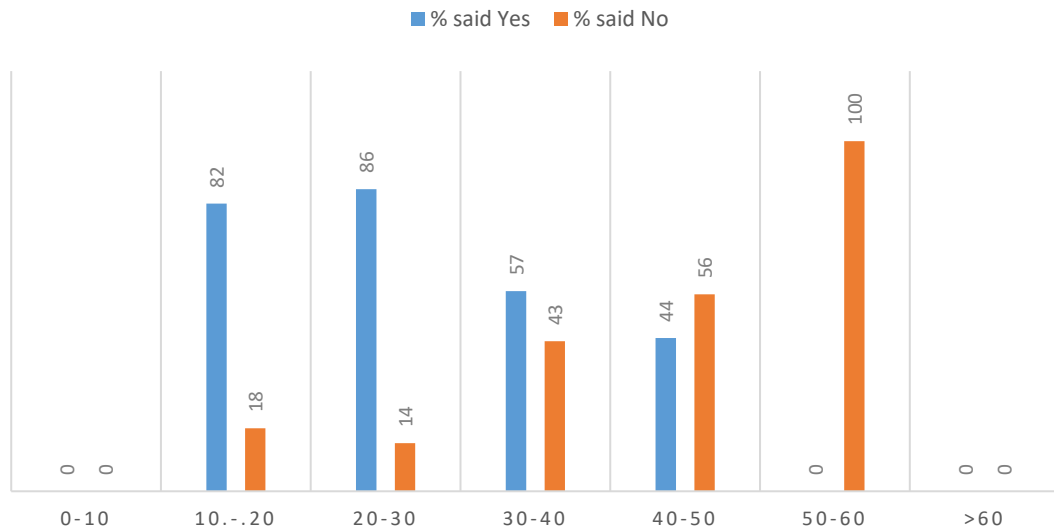


Figure 36 Shower usage per Age group

As it illustrated in the following table the usage of the laundry is low when compared to not only the goal of the project but also to the shower usage. Majority of the respondents did not use the PSU for washing their clothes. From the total of 120 respondents 85% of them didn't use the laundry in the PSU. 7% of them didn't know there is a laundry in PSU & they can wash their clothes.

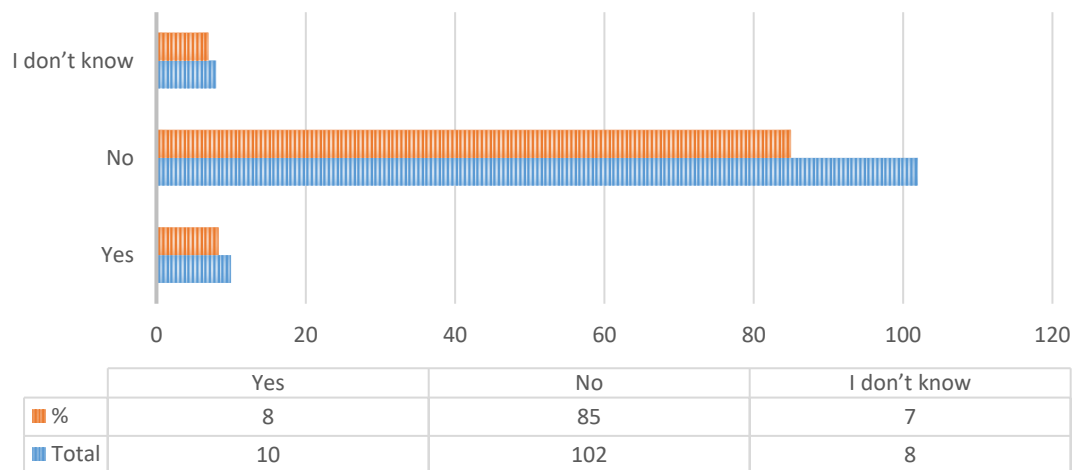


Figure 37 Laundry usage

PSU usage per Sex

As it is shown in the table below 66% of the total 88 male respondents, use the shower in the built PSU. In addition, 44% did not even use it once. From the total of 32 respondents 47 % of the respondents use the shower and 53% of them did not even use it once. The researcher try find why the respondents have not used it and get rich data and it will be discussed accordingly in the coming subtitles.

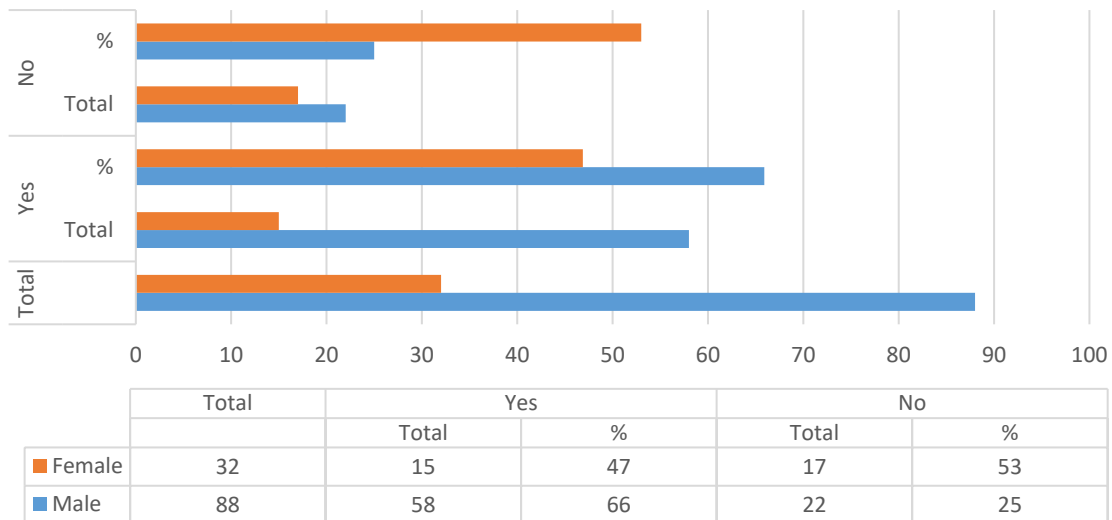


Figure 38 Shower usage per sex

Usage per religion

In this subtitle the researcher try to see if the usage frequency differs by religion and in the following table the data that is collected with the usage of the shower in the PSU is presented. As it can be seen from the chart below, from the 59 Muslim respondents 58% use the shower unit and on the contrary, 42% of the respondents did not use the shower unit even once. From the 48 Orthodox respondents 60% use the shower unit and on the contrary, 40% of the respondents did not use the shower unit even once. From the 13 Protestant respondents 77% use the shower unit and on the contrary, 23% of the respondents did not use the shower unit even once. This shows us majority of the population are Muslims and orthodox, the most frequent users of the PSU are Muslims and Orthodox.

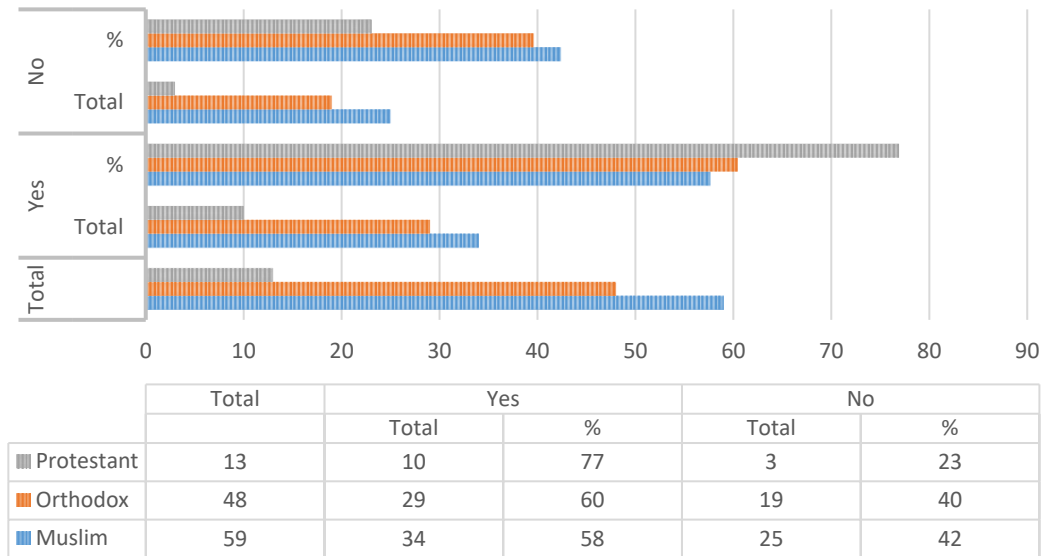


Figure 39 Shower usage per Religion

Usage per marital status

As it can be seen in the following chart from the total of 63 married respondents 59% of them use the shower in the PSU, however 41% of them didn't use shower in the PSU. And from the total of 57 bachelor respondents 63% of them use the shower in the PSU, however 37% of them didn't use shower in the PSU. This shows us the percentage of the usage differs per marital status, and the bachelor users have greater percent than married users.

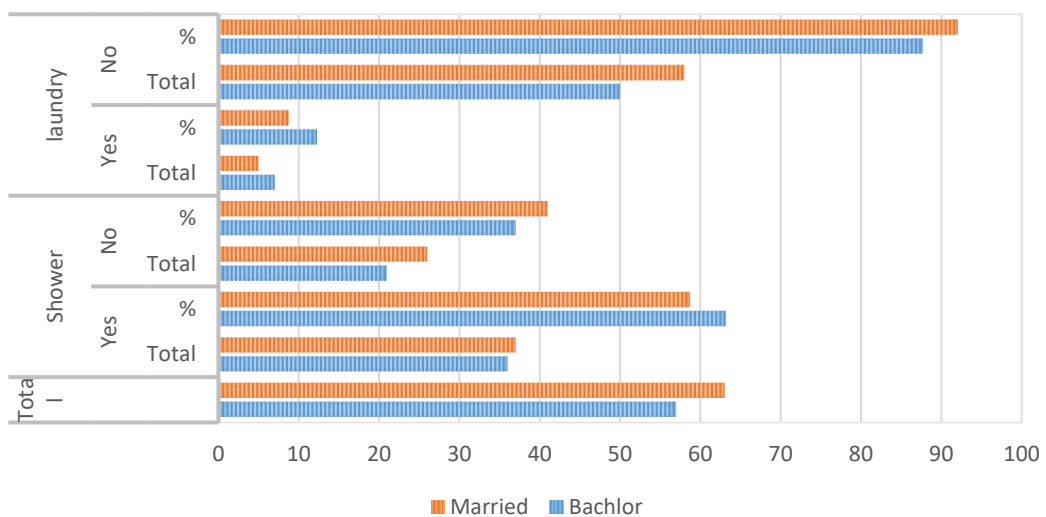


Figure 40 Shower usage per marital status

Shower taking trends of the community

The researcher try to see the trend of shower taking and laundry practice in the Wurerber community. Here the researcher have tried to see the frequency of shower taking per week and laundry activity per month. Since it have been observed the trend in the field observation.

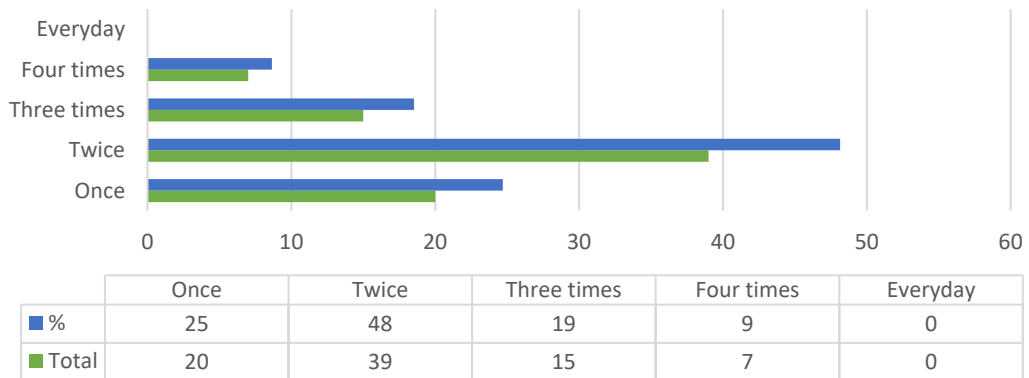


Figure 41 Shower usage frequency chart per week

Majority of the respondents' trend in the usage of shower is twice per week; hence, 48% of the 81 respondents wash their body twice a week. The second rank goes to showering once per week, which is 25% of the total 81 respondents. The third and the fourth rank goes to showering three times per week and four times, which is 19% & 9% from the total 81 respondents. No one from the respondents use shower every day.

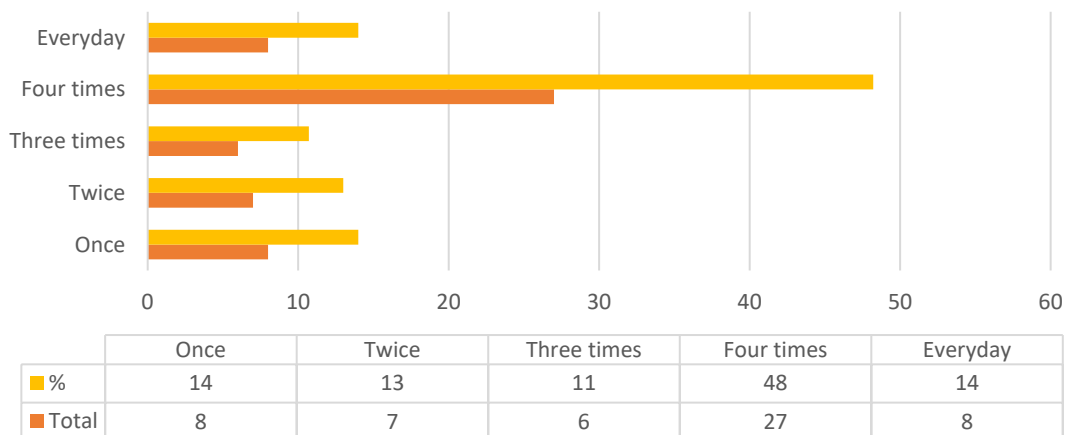


Figure 42 Laundry usage frequency chart per month

As it can be seen in the above table the laundry usage frequency per month, majority of the respondents, 48% of the total 56 respondents, wash their clothes four times per month, which is once per week.

The trend of the showering in Wurerber village before this shower unit was built is described in the following table. 57.5% of the 120 respondents wash their body on the river, 40% of the respondents wash their body in their house, and 2.5% of the respondents wash their body on the other place. Therefore, 41% of the respondents are continuing to use shower in the river and in their home.

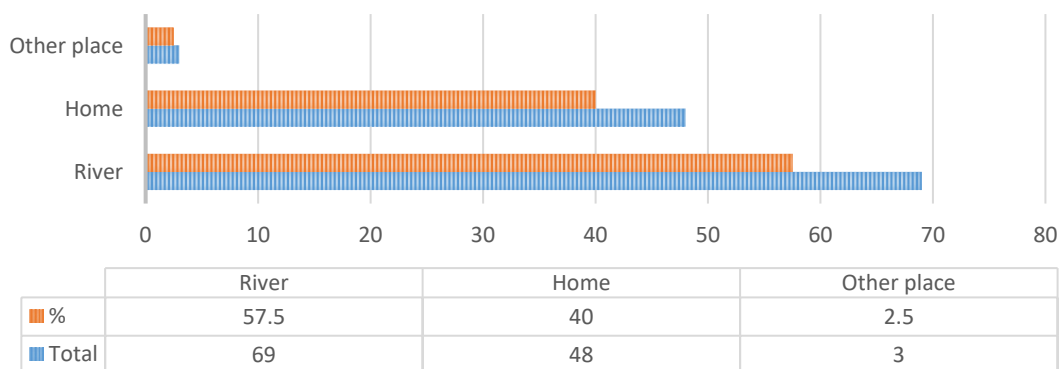


Figure 43 Shower taking place preference

As it is discussed before 85% of the respondents did not use the laundry in the PSU, so they are continuing to wash their clothes in the river and fetching water and washing in their home. The trend of laundry place is stated in the following chart. 80% of the total 120 respondents still use the river to wash their clothes and 20% wash in their home.

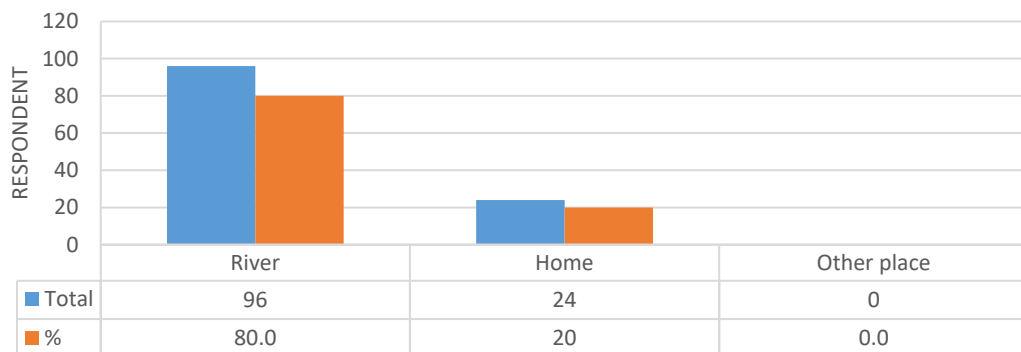


Figure 44 Laundry place preference

PSU Demand analysis

The researcher try to understand if there was a need for the PSU in the Wurerber community, and asked a question in the questionnaire survey that ‘Is this PSU is mandatory in the first place?’ and of the total 120 respondents 100 respondents, which is 83% of the total, responded that the PSU is mandatory for Wurerber community. Only 2% of the respondents said it is not. This shows us there is a high demand of the Integrated Sanitation Unit for showering and laundry in the community.

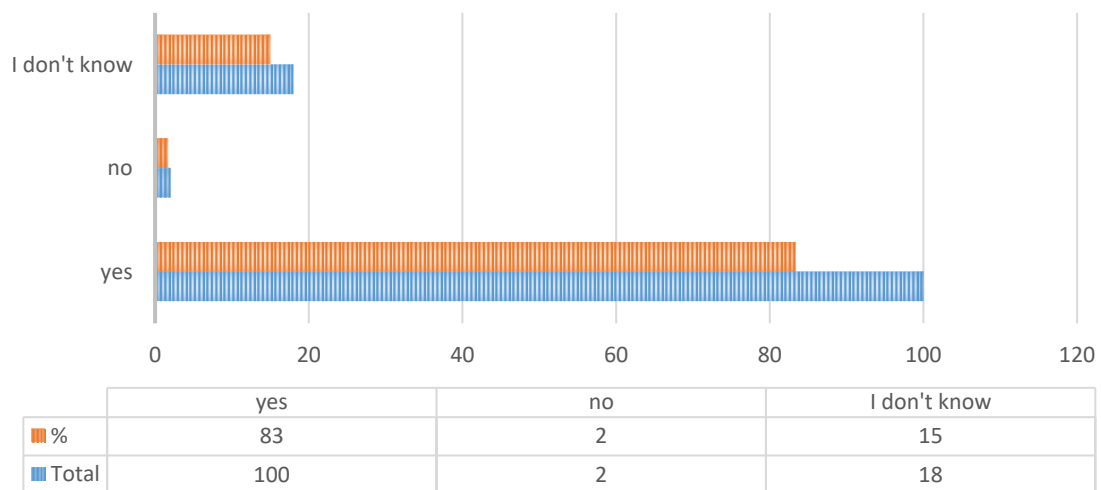


Figure 45 PSU overall demand

Discussion on the reduced rate of utilization of the sanitation unit

To study the utilization rate of the sanitation unit, the researcher tries to see the usage frequency as the main point of comparison of the mismatch. If the inhabitants accept the unit, they will use it accordingly. So by taking different scenarios for studying the factors to see the unit acceptance to the public. According to the analysis pattern. The discussion will be thru as follows.

A. Discussion of the Demand concerning the demographic features

The trend of showering is 57.5% of the 120 respondents wash their body on the river, 40% of the respondents wash their body in their house, and 2.5% of the respondents wash their body on the other place. Therefore, 41% of the respondents are continuing to use the shower in the river and their home. This shows us the utilization of the unit is minimized by 41% of the total population.

From the analyzed data, It is found that the demand for the sanitation unit differs in different age groups. The majority of the users of the sanitation unit are from 30-40 years age groups, and the last ones to use the integrated infrastructure sanitation unit are from less than 10 and greater than 60 years age groups. This corresponds with the data that is found on the on-site observation. As the researcher asks, why the older inhabitants did not use the PSU? The respondents responded the young's and elders didn't use it because the young's couldn't afford it and the operation of the shower appliances become difficult to reach because of the height problem and the elders didn't want to go out to wash their body, and they prefer to fetch the water and wash in their home.

When the response values are taken on the sex of the respondents and compare the acceptance, the males are using the shower most of the time than females. There is low usage of females on the shower unit, the researcher try to ask why on the on-site observation, and found that they didn't use it because they prefer a private space rather than the public one. They also need a unisex space for better usage.

However, what it is found in the data analysis when we take the religion as the main parameter for comparing the usage frequency, the demand is more or less the same. Nearly 60% of the users of the unit are Muslims, this shows us the majority of the population are Muslims and orthodox, the most frequent users of the PSU are Muslims and Orthodox. To compare the PSU usage per marital status the percentage of the usage differs per marital status, and the bachelor users have greater percent than married users. Since the Muslim married users, they have to take a shower early at 6:00 PM. However, the PSU has not been opened at that time and because of comfortability issues that will be discussed on the following subtitles; the usage for the married Muslims becomes low.

Majority of the respondents' trend in the usage of the shower is twice per week; hence, 48% of the 81 respondents wash their body twice a week. The days are not the same for all the inhabitants. However, the majority of the Muslims prefer to wash their body on Friday and the Christians prefer Thursday or Sunday.

The usage of the laundry is low when compared to not only the goal of the project but also to the shower usage. Majority of the respondents did not use the PSU for washing

their clothes. From a total of 120 respondents, 85% of them didn't use the laundry space in the PSU. Seven percent of them did not know there is a laundry in PSU & they can wash their clothes.

For the demand regarding public sanitation unit as a whole from the total 120 respondents 100 respondents have responded it is mandatory. Which is 83% of the total, responded that the PSU is mandatory for Wurerber community. Only 2% of the respondents said it is not mandatory. This shows us there is a high demand for the public Sanitation Unit for showering and laundry in the community.

C. Analysis of values of infrastructure service affecting the rate of utilization

Geographical values

As it is discussed in the literature review "Geographies of enablement and constraint" (Law & Bijker 1992). As discussed in Law & Bijker the geographical location of the IIU also have an impact on the comfort of the community. In this subtitle, the researcher try to find whether the usage of PSU relates with geographical location of the inhabitants in Wurerber and nearby villages. When the location is far from their living place the usage, frequency decreases.

As shown in the chart below from 120 respondents 51% of the respondents responded the location of PSU is far from them, 49% of the respondents responded the PSU is near their living place. The researcher also tried to find the far and near values in numbers, and find that 10% of the respondents live 20-50 meters from PSU, 14% of the respondents live 50-100 meters from PSU, 8% of the respondents live 100-200 meters from PSU, 17% of the respondents live 200-500 meters from PSU, and 52 % of the respondents live more than 500 meters from PSU. This showed us 52% are not using the PSU because the location of the PSU is far from their living place.

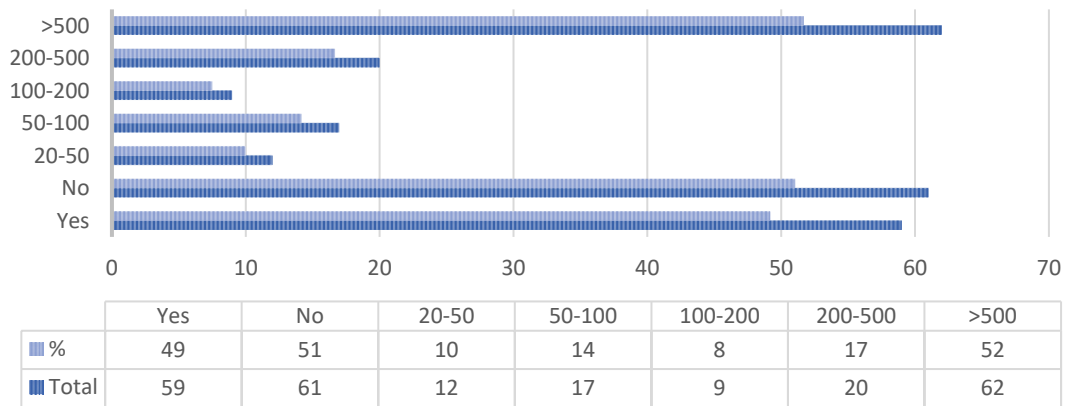


Figure 46 Location analysis chart

The researcher also tried to compare the distance of the river from their living place, since they are using the river for showering and laundry. And the data will be presented in the graph below.

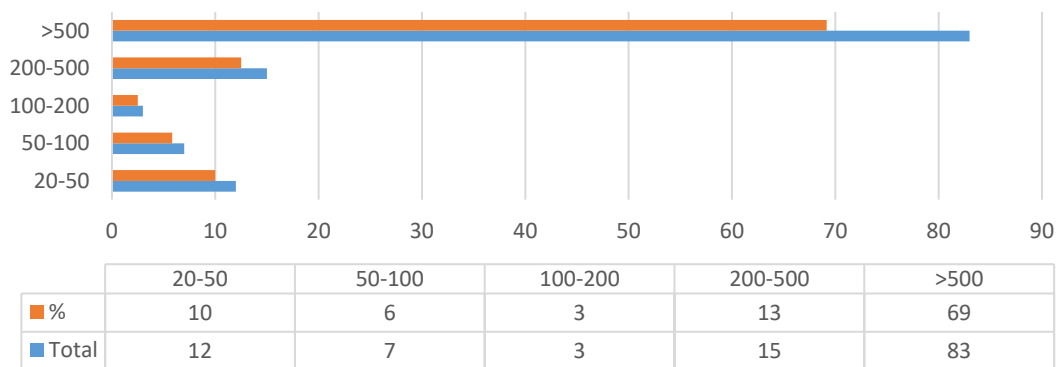


Figure 47 Distance from the River chart

As shown in the chart above, 69% of the respondents said that the river is far, which is greater than 500 meters from their living place, but they are still going there and using it as a showering and laundry activity.

In the table below, the researcher try to make the respondents rate the location of the PSU from their living place and find the following data. 8% of the respondents give an excellent rate, 16% of the respondents give an great rate, 32% of the respondents give an good rate, 13% of the respondents give an poor rate, 33% of the respondents give an very poor rate. This shows us 46% of the respondents are not satisfied with the location of PSU from their living place.

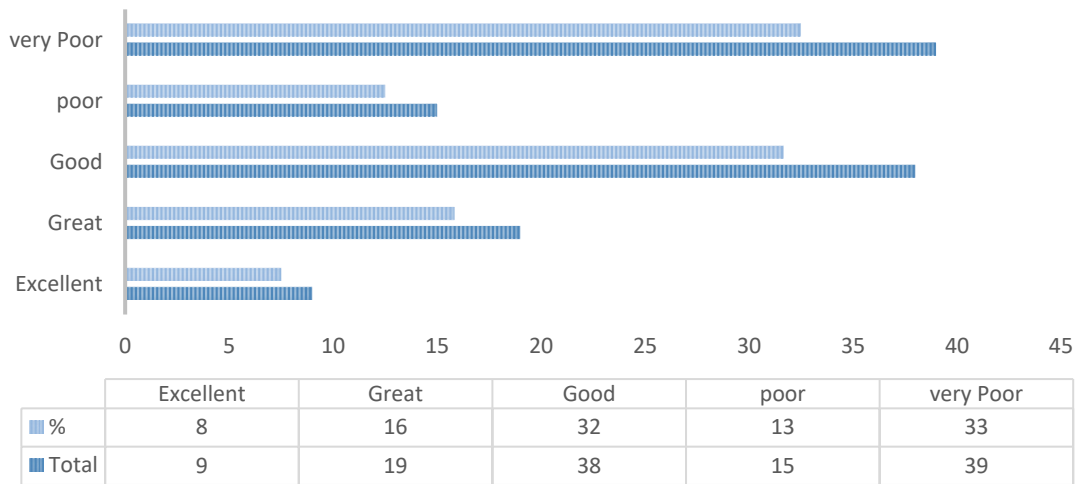


Figure 48 Location rating chart

Behavioral values

In this subtitle, the researcher try to find if there is a relation between the interactive values of PSU with the users. As it is discussed, in the theoretical framework review the user will decide whether he uses the built unit or not, for this the behavioral aspects of the PSU should be. For this case, the researcher produced questions regarding the behavioral values of the user. It will be summed up the collected data on this aspect in the following chart.

First of all the researcher have tried to see whether the respondents find the PSU attractive or not. As it can be seen from the chart, 60% of the respondents said that the PSU is attractive for them, 23% responded it is not attractive and 17% responded I don't know. This show us more than half of the respondents think that the PSU is attractive in its appearance, so there is no need to deal with the attractiveness on the overall look.

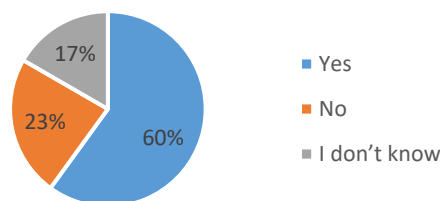


Figure 49 PSU Attractiveness chart

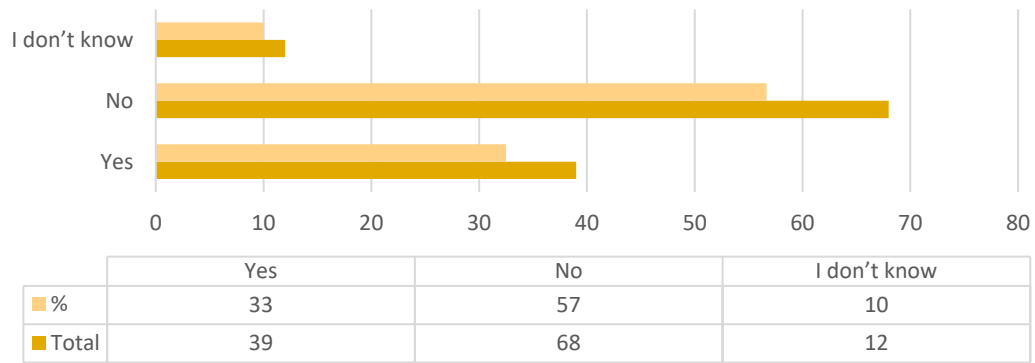


Figure 50 Meeting Expectations of the users chart

In the chart above, the researcher try to find whether the PSU meet the expectations of the community in general before getting to specific details, and it is found that 57% of the respondents are not satisfied in meeting their expectations, 33% are satisfied and the rest 10% responded I don't know. From the 33% who responded yes, the researcher have tried to see the level of their expectation meeting in terms of ratings and found that 20% of them responded that they are more than well satisfied, 64% responded well satisfied and 15% less than well satisfied. This show us there is still something missing even for the 'yes' respondents.

Table 8 Expectation meeting level

Response	Total	%
Extremely well	4	10
Very well	4	10
Well	25	64
Not so well	6	15
Not at all well	0	0

Table 9 PSU in terms of sense of security

Response	Total	%
Yes	33	34
No	55	56
I don't know	10	10

On the table above, the researcher try to find the satisfaction of the respondents on sense of security when they use PSU. And find that only 34% are satisfied with the PSU sense of security, and 56 % of the users didn't feel secured when they use PSU.

As it is discussed on the theoretical framework review luminance have effect on the quality of service provision. Moreover, the researcher tried to find if there is any problem that the users feel when they use PSU in terms of lighting quality. As indicated on the chart 85% of the respondents are satisfied with the lighting quality of PSU.

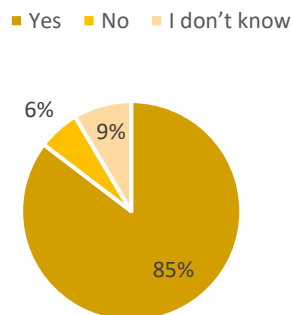


Figure 51 PSU in terms of lighting quality rating

In the following chart the researcher try to show what the respondents responded on the questionnaire survey regarding the sense of privacy when they are using PSU. And found that 63 % of the respondents have problem in privacy issues when they are using the unit. Only 37% have no problem on this issue.

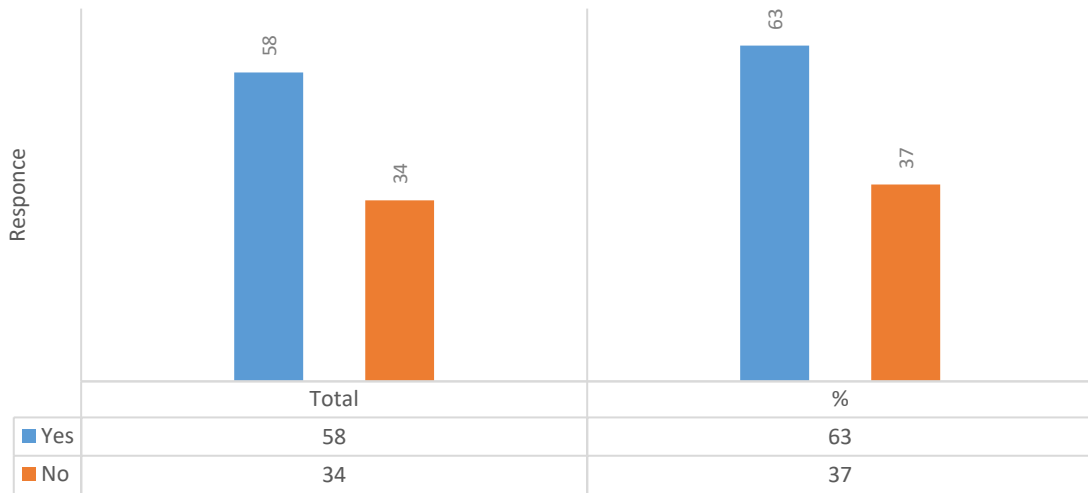


Figure 52 PSU with respect to privacy

As shown in the following chart the researcher was interested what the respondents' trend is on washing their clothes whether they prefer to wash alone, with friends or with family. And the data which the research got on the sociality preference for using laundry is discussed as follows. 32% of the respondents prefer washing their clothes alone, 46% of the respondents prefer washing their clothes with friends, 22% of the respondents prefer washing their clothes with family. From the collected data, we can analyze that 67% of the respondents are interested in social collectivity whether in family or in friends for washing their clothes.

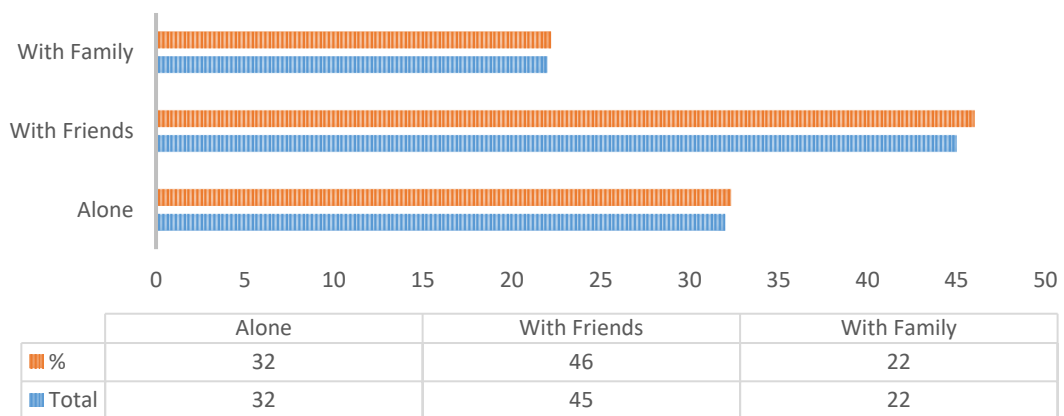


Figure 53 Social preference for laundry

Regarding the trend of washing clothes environment like indoor washing, outdoor washing or anywhere may be also the factor for not using the laundry in the enclosed space in the PSU. And the collected data is presented as follows. For washing trend, 80% of the respondent's trend for washing their clothes is outdoor, 16% of the respondent's trend for washing their clothes is indoor, 4% of the respondent's trend for washing their clothes is anywhere. From this, we can see why the PSU have failed in terms of space design for laundry.

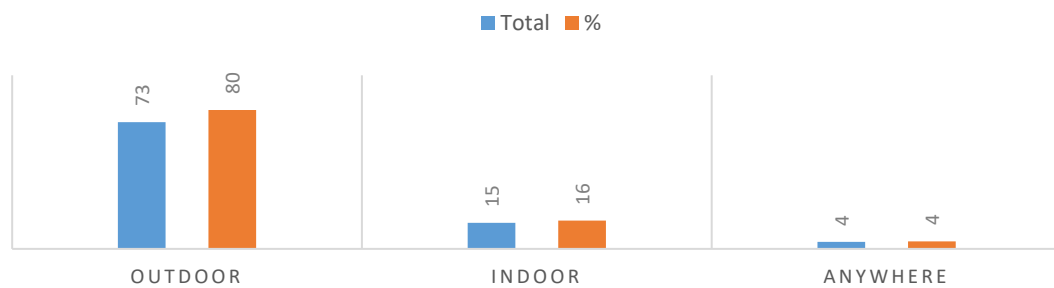


Figure 54 Washing space trend

In the following chart, the researcher have tried to see which time of the day the respondents for taking a shower prefer. For the study, the day was divided in to four like morning afternoon, night and midnight with 6-hour interval starting the day at 12 o'clock local time. And it is found that 44% of the 98 respondents take a shower in the morning, 37% of the 98 respondents take a shower in the afternoon, 18% of the 98 respondents take a shower in the night time and no one takes a shower in the mid night. This shows us there are more respondents, which use a shower in the morning, since the majority of the population are Muslims before they go to mosque they use a shower mostly in Fridays, and most of the Christians use a shower on the weekends.

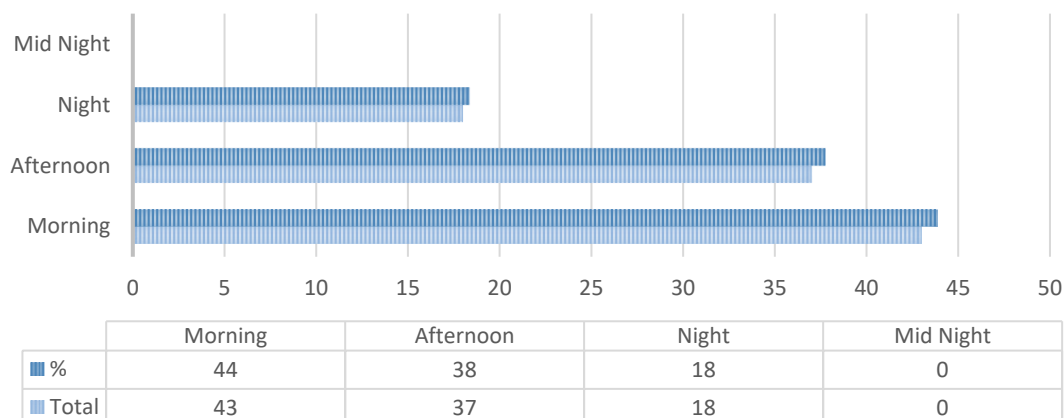


Figure 55 Shower taking time trend

Functional values

Here the researcher try to find the responses on some selective issues regarding functional aspects of the built and functioning PSU. Specific details regarding these values will be discussed in the following charts. The first thing in the functional values, the researcher try to find if there are any problems regarding circulation spaces in the PSU. As it can be seen in the following table 30% of the total respondents replied they have encountered problems in the circulation space, 61% of the total respondents replied they have no any problems in the circulation space and 9% replied they don't know.

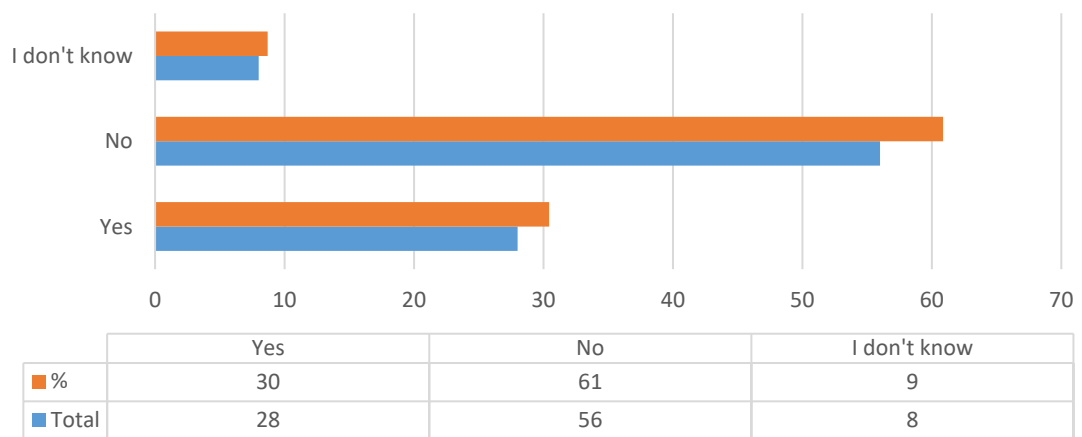


Figure 56 PSU Circulation space

In the following chart, the collected data regarding the comfortability of the partition space will be discussed. Of the total 94 respondents, 60% of them are not comfortable on the partition, 38% of them are comfortable on the partition, and 2% responded I don't know. As the researcher try to ask some following questions on the partition material is not comfortable for them to use the shower.

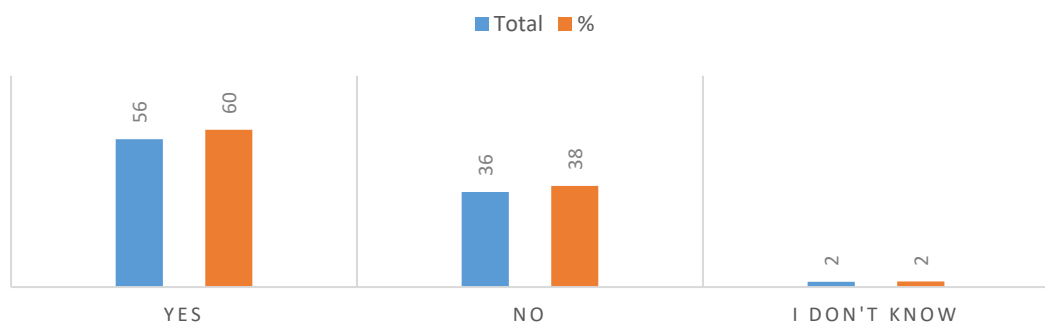


Figure 57 Partition comfortability rating

Since one of the functional space in PSU is waiting space, the researcher tried to find whether the designed and provided space is necessary for the respondents. In an on-site observation, the researcher saw that no one is using that space for any activity. In addition, the researcher have tried to develop questions, which shows the preference of this specific space as either 'waiting inside' or 'waiting outside'. Moreover, 86% of the total 94 respondents replied they prefer to wait outside and 9% of the total 94 respondents replied they prefer to wait inside.

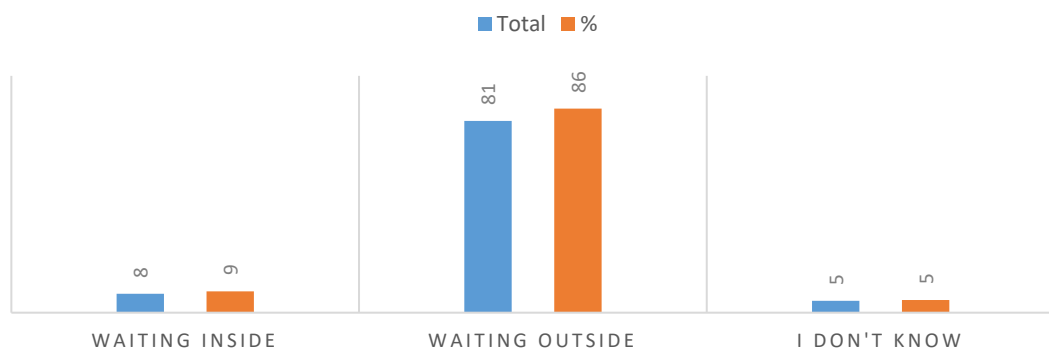


Figure 58 Waiting space preference

Table 10 Spaces to be added for extra comfortability

Response	Total	%	Rank
out door shade	58	23	3
Toilet	79	31	1
Parking	25	10	5
Coffee and tea spot	32	12	4
Others	63	25	2

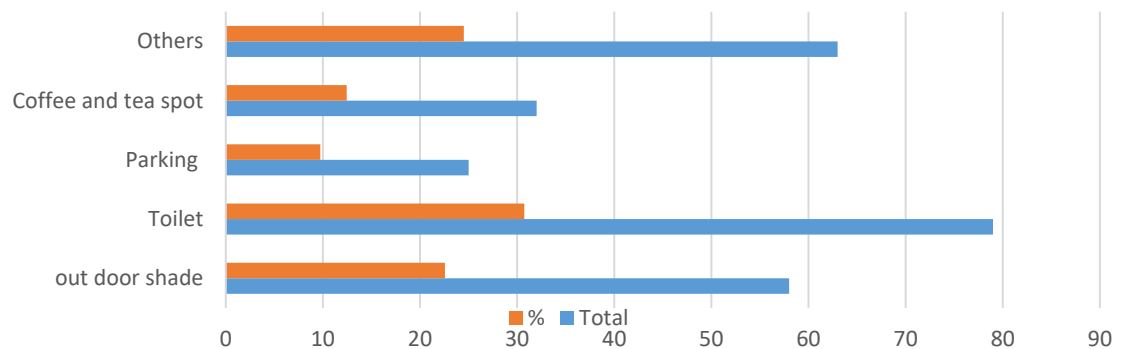


Figure 59 Spaces to be added for extra comfortability

As shown in the chart and table above the researcher try to collect data if any functional spaces is to be added what it should be, and the research have tried to give some spaces based on my previous onsite observation and pilot study. And of the total 257 responses the survey have tried to make the spaces to be added in rank of 5 based on the response from the respondents and get the result 39% of the respondents need a toilet to be added on PSU and get the first rank. 25% of the respondents need other functions like car wash, fixed partition for the shower units, water reservoir, park and compound for PSU to be added on PSU and get the second rank. And 23% of the respondents need an outdoor shade to be added on PSU and get the third rank, 12% of the respondents need a coffee and tea spot to be added on PSU and get the fourth rank, 10% of the respondents need a parking to be added on PSU and get the fifth rank.

As shown in the graph below, the researcher try to find if the PSU fulfils the social needs of the community. And the researcher have put some social spaces which are expected on such kind of communal facilities like availability for old and disabled people, composition of recreational grounds for children and adults, composition of playgrounds and greenery. First on the survey tried to give the respondents to make a rating if there is any, and for all of them more than 85% responded that the composition of these social spaces are very poor.

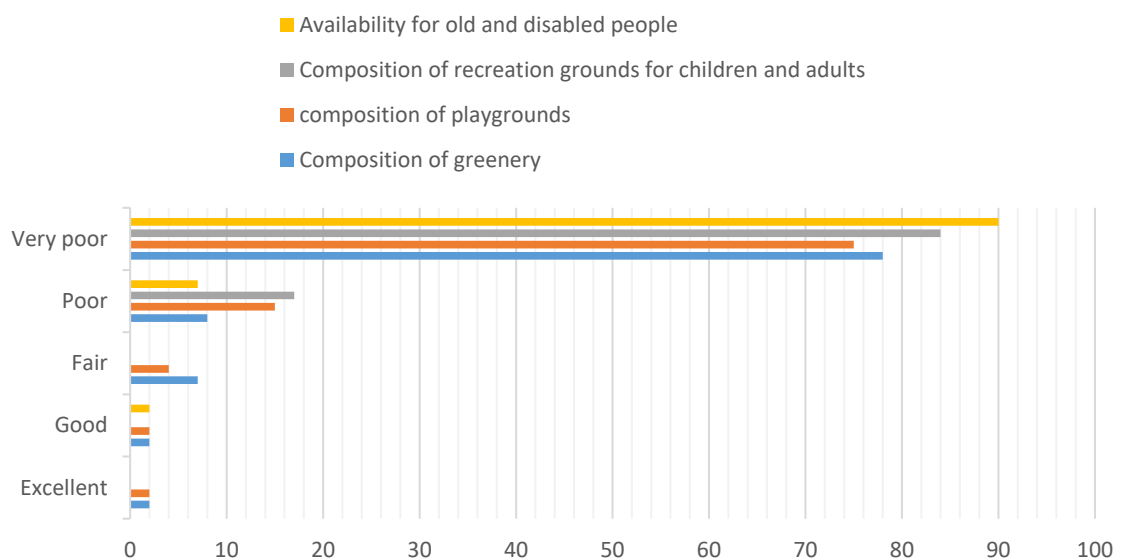


Figure 60 PSU with respect to fulfilling social needs

Technical values

In this subtitle the researcher will try to find one of the contributing factors for the under usage of the PSU, which is taken as one of the six independent variables. The specific details regarding the project like laundry comfortability, water supply consistency, price and universality of the PSU will be analyzed. First the researcher tries to find why the respondents are not using the laundry and the frequency of the usage of the shower unit.

From the 92 respondents who responded to the question of the comfortability of the laundry 85% responded the laundry is not comfortable that is why they are not using the unit, and only 15% of the respondents responded the laundry is comfortable. Then the researcher try to find why it is not comfortable for them to use the laundry, is it the problem of laundry space, Barrel size, barrel material or the whole barrel design? And the collected data regarding this will be discussed as follows. Of the total respondents more than 63% of think that there is a problem on the laundry space, barrel size, barrel material and the overall barrel design. This is a contributing factor for under usage of the laundry in the integrated sanitation unit in Wurerber Kebele.

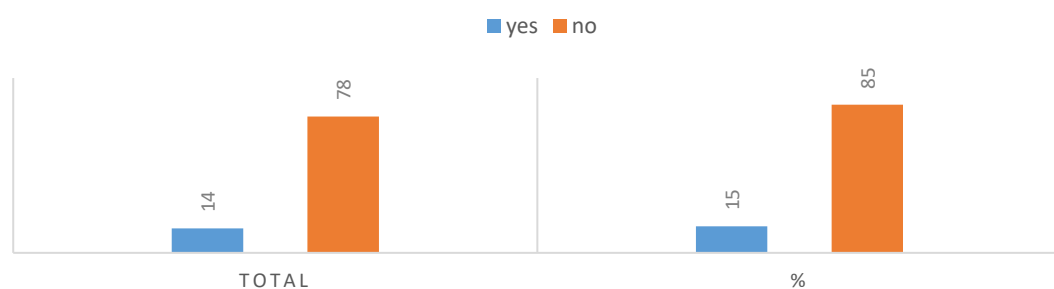


Figure 61 PSU Laundry comfortability

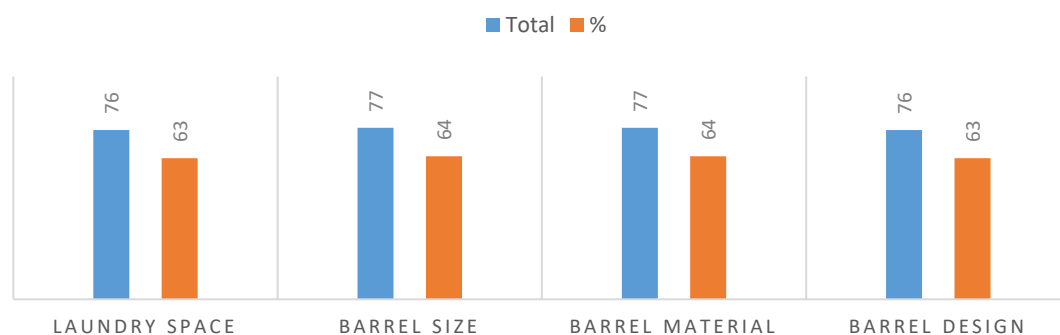


Figure 62 PSU Laundry problems

The researcher then try to see the next contributing factor, which is the water resource consistency, and found the following data. In order to evaluate this the researcher have developed a five scale points, which are excellent, very good, good, poor and very poor. And from the total of 95 respondents 4%give the water resource consistency excellent, 3%give the water resource consistency very good, 11%give the water resource consistency good, 36%give the water resource consistency poor and 45%give the water resource consistency very poor. This show us 77% of the respondents are suffering on a problem of water unavailability when they go to use the shower or laundry in PSU.

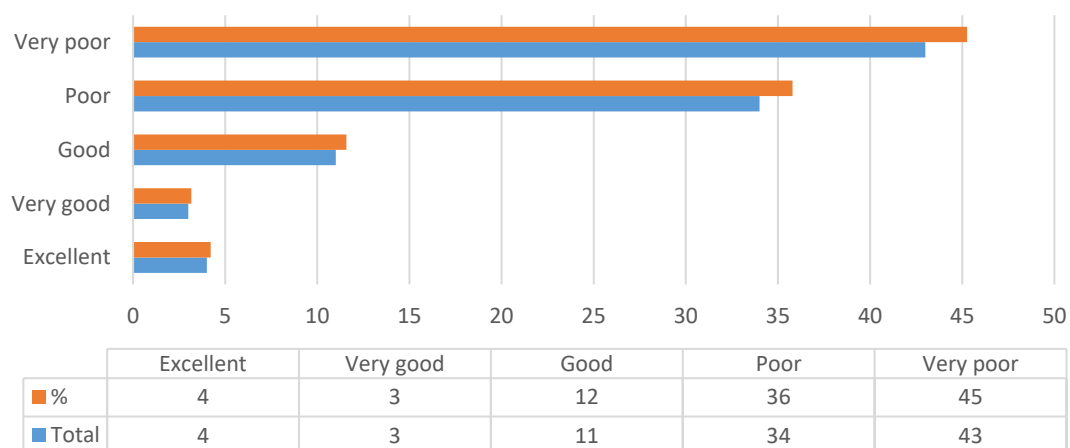


Figure 63 Water consistency Rate

In the following chart, the researcher have tried to collect data regarding the physically challenged people and try to see if there is any consideration on the design of the PSU for them. 7% of the total 120 respondents are physically challenged and 93% are physically well. However, on the design of the PSU there is no consideration for them. And the unit is evaluated based on the rate of the users on scale of 5 like excellent, very good, good, poor and very poor. And find that none of the respondents give excellent or very good, 5%give the universality of PSU good, 42%give the universality of PSU poor and 53%give the universality of PSU very poor. This show us 95% of the respondents think that the PSU did not give any consideration for universality of the unit for physically challenged users.

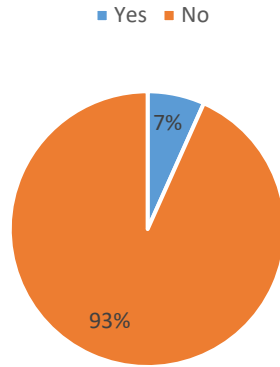
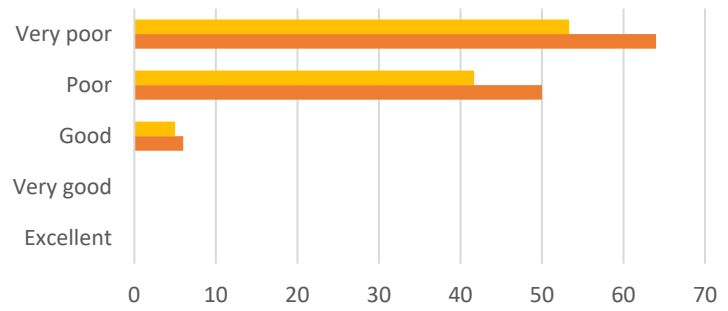


Figure 64 physically challenged among the respondents (Left).



	Excellent	Very good	Good	Poor	Very poor
■ %	0	0	5	42	53
■ Total	0	0	6	50	64

Figure 65 PSU Universality Rate (Right)

The last one the researcher try to know about the technical values of the PSU is about the economical affordability of PSU. In my onsite field observation it is observed that the users pay 7 birr for using a shower on this sanitation unit, with a soap. Before going to the preference analysis of the users among affordability of PSU, first the income of the respondents had been surveyed. And find that from the total of 120 respondents, 38% of the respondents are farmers, 18% of the respondents are students, 17% of the respondents are labors, 8% of the respondents have no work, 7% of the respondents are merchants, 7% of the respondents are housewives, 3% of the respondents are employees, 2% of the respondents are Bajaj riders, 2% of the respondents are barbers. And from my field observation it have seen that there is no much cash in hand of the society, since the farmers cultivate for their consumption.

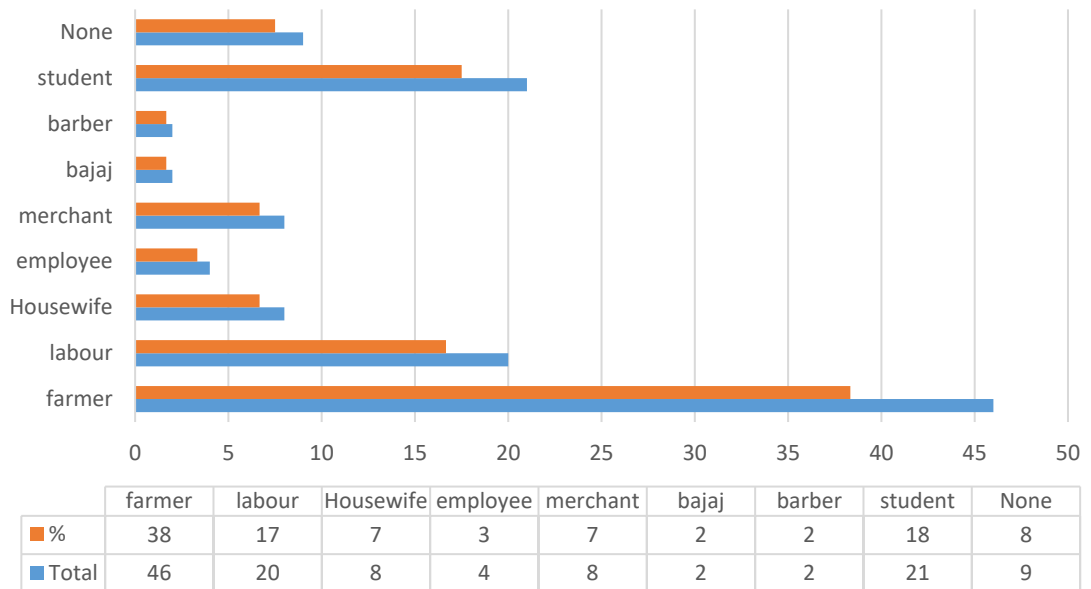


Figure 66 Respondents Means of Income

After this the researcher have given them the question to rate the price to use the shower and laundry service in PSU. And found that 18% think the cost is fair to use PSU, But 82% think that the price is too high to afford to use a shower. The chart below shows the preference of the cost that the respondents can afford. From total 92 respondents 4% of them can afford to pay 1 birr to use the PSU, 29% of them can afford to pay 2 birr, 37% of them can afford to pay 3 birr, 2% of them can afford to pay 4 birr, 27% of them can afford to pay 5 birr. The average will be 3 birr and even most of the respondents can afford 3 birr to pay for the service.

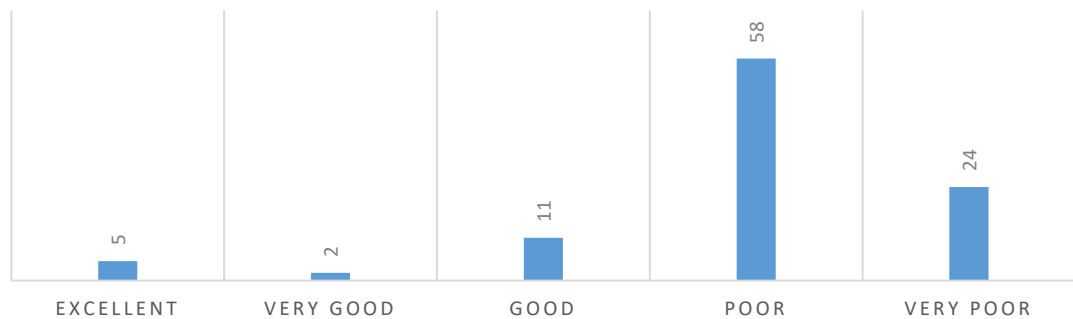


Figure 67 PSU Affordability

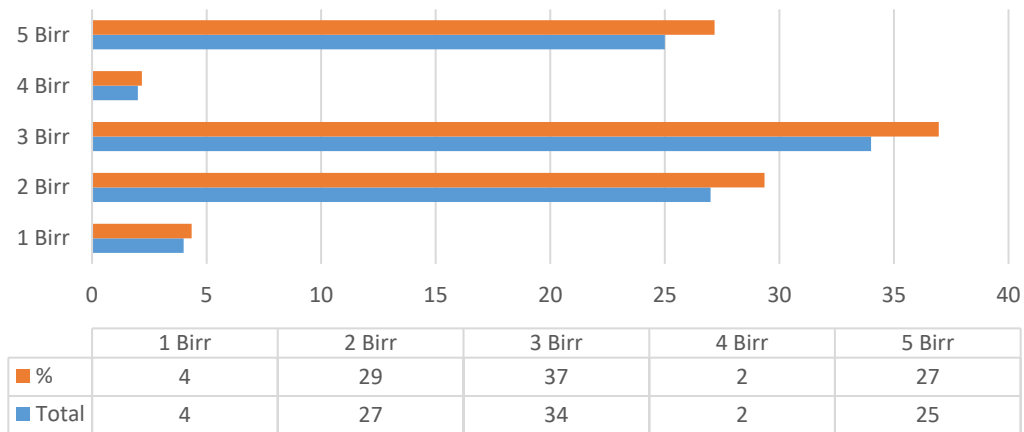


Figure 68 Price affordability of respondents

Managerial values

In this subtitle, the researcher will try to find the management performance in managing and controlling the PSU. Because the availability and the good organization of the project will have an influence on the usage frequency of the unit. So first, the researcher will try to find the availability of the manager or concerned body on the unit always and whether the users ever find it closed and left disappointed. For this question, the collected data will be analyzed as follows. From the total of 120 respondents, 53% responded they have found it closed, 22% responded they always get it open and 31% responded I do not know.

Then the researcher try to find how many times they got it closed for the ones that responded 'we find it closed'. And found that from the total 63 respondents, 62% find it closed 1-5 times, 17% find it closed 5-10 times, 8% find it closed 10-15 times and 13% find it closed more than 15 times. This show us there are many users suffering from the close up of PSU when they come to use any sanitation facility in the unit.

Table 11 Close-up of the PSU

Response	Total	%
Yes	63	53
No	26	22
I don't know	31	25

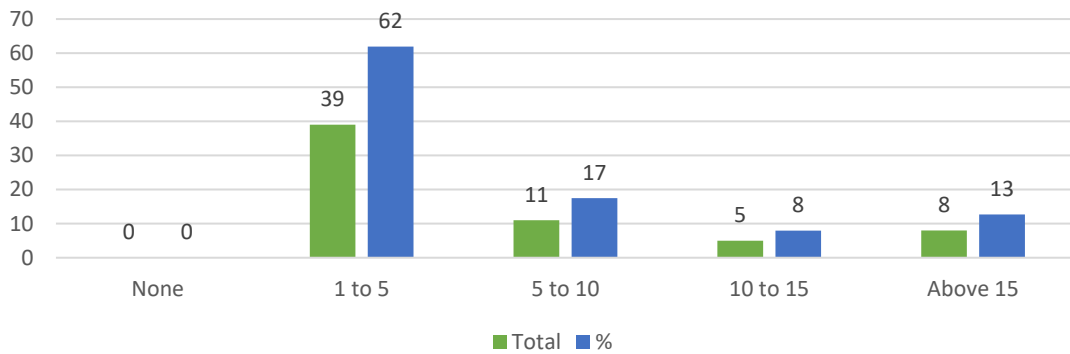


Figure 69 Respondents found PSU closed rating

Next, the researcher try to see the feeling of comfortability when the users complain or voicing their concerns regarding the public sanitation unit (PSU). As it can be shown on the graph below the rate of comfortability on raising complaints is 13% responded excellent, 3% responded Very good, 43% responded good, 28% responded poor and 14% responded very poor. This show us 42 % of the total 101 responded to the question, they have problems on raising their voice for the concerned management body.

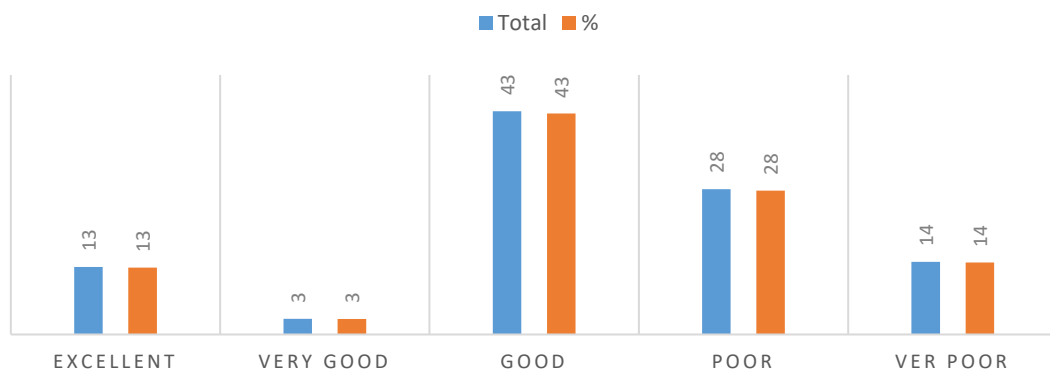


Figure 70 Raising complaints comfortability chart

The researcher also try to find if the management gives immediate solution for the problems raised by the users. And found that 49% of the total 100 responded to the question said yes, 40% of the total 100 responded to the question said no and 11% of the total 100 responded to the question said I don't know. This show us there is a problem for the users to get an immediate response from the management on the issues they raised.

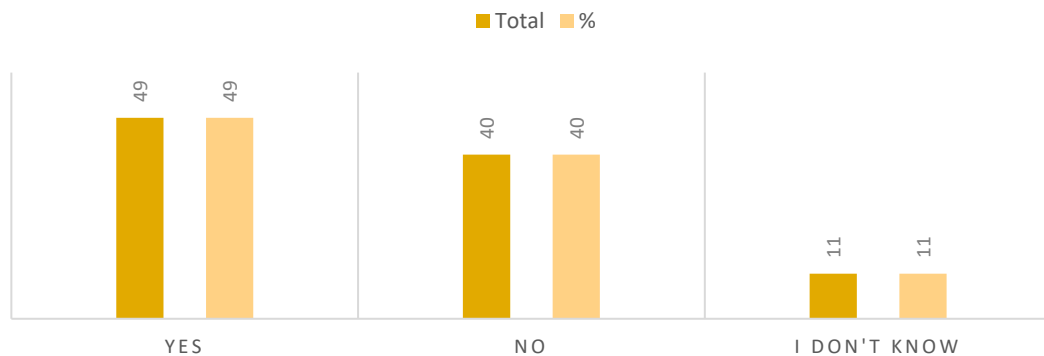


Figure 71 Management immediate solution giving rating chart

Discussion on the analysis of values of infrastructure service affecting the rate of utilization

As it is discussed by “Geographies of enablement and constraint” (Law & Bijker 1992), the geographical location of the PSU has an impact on the comfort of the community. This can be seen on the data analyzed from the questionnaire survey, under the subtitle of geographical aspects survey. From 120 respondents 51% of the respondents responded the location of PSU is far from them, 49% of the respondents responded the PSU is near their living place.

From this 52 % of the respondents live more than 500 meters from PSU. 46% of the respondents are not satisfied with the location of PSU from their living place, because they give the rating for the sanitation unit poor and very poor. What has been concluded from all this is that when the location is far from their living place the usage frequency decreases. The researcher also tried to compare the distance of the river from their living place, since they are using the river for showering and laundry. And found that nearly 67% of the respondents responded that the river is far from their living place, but they still prefer it for their sanitation needs, so what this can show that there are other contributing factors for not using the built public sanitation unit.

According to (Charytonowicz, J. 2018), the behavioral concepts Under consideration are applied design solutions, equipment, small architecture facilities, quality of lighting and the number of light points, color, materials, and greenery the sense of climatic

comfort (quality of air, pollution, sound level, and transport nuisance). So first, it have been tried to see if there is a problem with the behavioral aspects of the sanitation unit. As it is discussed, in the theoretical framework review the user will decide whether he uses the built unit or not, for this the behavioral aspects of the PSU should be premeditated. For this case, the questions regarding the behavioral values of the user are produced. From the data analyzed, more than half of the respondents think that the PSU is attractive, so there is no need to deal with the attractiveness on the overall look. Then the researcher tries to find other behavioral quality factors. The researcher tries to find whether the PSU meets the expectations of the community in general before getting to specific details, and found that 57% of the respondents are not satisfied in meeting their expectations. From the 33% who responded the unit have met their expectation, I have tried to see the level of their expectation meeting in terms of ratings and found that 15% of them said that they are less satisfied.

As can be seen in figure 47, the researcher tries to find the satisfaction of the respondents on a sense of security when they use PSU. In addition, find that only 34% are satisfied with the PSU sense of security, and 56 % of the users didn't feel secure when they use PSU. Then the researcher tries to see what the respondents responded on the questionnaire survey regarding the sense of privacy when they are using PSU. And found that 63 % of the respondents have a problem in privacy issues when they are using the unit. The contributing factors are due to the spatial arrangement of the spaces and also the unisex problems and the movable partition.

As can be seen in figure 48, the researcher was trying to find what the respondents' trend is on washing their clothes whether they prefer to wash alone, with friends or with family. And the data which is found on the sociality preference for using laundry is discussed as follows. From the collected data, we can analyze that 67% of the respondents are interested in social collectivity whether in a family or in friends for washing their clothes. This shows that there is a high demand for social collectivity rather than loneliness in washing clothes.

Regarding the trend of washing clothes environment like indoor washing, outdoor washing or anywhere maybe also the factor for not using the laundry in the enclosed space in the PSU. And the collected data show us 80% of the respondents prefer

washing their clothes in an outdoor environment. So this is also the contributing factor for the low PSU laundry usage.

From the data the time preference of using a shower, there are more respondents which use a shower in the morning, since the majority of the population are Muslims before they go to the mosque they use a shower mostly on Fridays, and most of the Christians use a shower on the weekends.

Then the researcher tries to see if the PSU functional aspects are the contributing factors for the underutilization of the sanitation unit. According to (Charytonowicz, J. 2018) Functional solutions are analyzed paying special attention to the adaptation of the size, composition, and solutions of the common space, which enables the activity of users of the given space (simultaneously eliminating unfavorable behavior, that is, occurrence of antisocial behavior). The quality in question includes functioning of buildings and space resulting from grouping the function related to the hierarchy of space influencing its accessibility.

Spatial and mobility requirements of people with various levels of fitness should be assumed as benchmarks used for the shaping of space and ways of distribution of elements, which fill it. What is vitally important is taking into consideration of particular needs of people with lower mobility (disabled people, children, the elderly and people suffering from obesity). (Charytonowicz, J. 2018) So first, the researcher collected data if the respondents have any issues on the circulation space, and found that 61% of the total respondents replied they have no any problems in the circulation space, but still 30% of the respondents say they are not comfortable with the circulation.

For the comfortability of the partition space, the data, which analyzed from the respondents, is discussed as follows. From the total respondents, 60% of them are not comfortable on the partition space and material. Since one of the functional space in PSU is waiting for space, the researcher tries to find whether the designed and provided space is necessary for the respondents. In on-site observation, the researcher saw that no one is using that space for any activity. And the researcher have tried to develop questions which show the preference of this specific space as either 'waiting inside' or 'waiting outside'. And 86% of respondents replied they prefer to wait outside. This shows there is no need for the waiting space in the interior spaces.

As shown in figure 54, the researcher tries to collect data if any functional spaces are to be added what it should be, and some spaces based on an previous onsite observation and pilot study had been given for the respondents. 39% of the respondents need a toilet to be added on PSU and get the first rank. 25% of the respondents need other functions like a car wash, fixed partition for the shower units, water reservoir, park and compound for PSU to be added. And 23% of the respondents need an outdoor shade to be added on PSU, 12% of the respondents need a coffee and tea spot to be added on PSU, 10% of the respondents need park to be added on PSU.

As shown in figure 55, the researcher tries to find if the PSU fulfills the social needs of the community. Moreover, the researcher put some social spaces, which are expected on such kind of communal facilities like availability for old and disabled people, the composition of recreational grounds for children and adults, composition of playgrounds and greenery. First it is given for the respondents to make a rating if there is any, and for all of them, more than 85% responded that the composition of these social spaces is very poor.

Then the researcher had collected data concerning the technical features of the PSU and have to try to find one of the contributing factors for the under usage of the PSU, which is taken as one of the six independent variables. The specific details regarding the project like laundry comfortability, water supply consistency, price and universality of the PSU had been analyzed. First, the researcher tried to find why the respondents are not using the laundry and the frequency of the usage of the shower unit. 85% responded the laundry is not comfortable that is why they are not using the unit. The researcher tries to find why it is not comfortable for them to use the laundry, is it the problem of laundry space, Barrel size, barrel material or the whole barrel design? And the collected data regarding this is discussed as follows. Of the total respondents more than 63% of think that there is a problem on the laundry space, barrel size, barrel material, and the overall barrel design. This is a contributing factor for under usage of the laundry in the public sanitation unit in Wurerber Kebele.

According to (United Nations, 2014), restoring the balance between natural and human-made infrastructures needs to be recognized as an important element to reconstruct water and energy access. Water sensitive development involves simple design and management practices that take advantage of natural site features and minimize impacts

on the water cycle. It is part of the contemporary trend towards more 'sustainable' solutions that protect the environment. Therefore, the researcher then tries to see the next contributing factor, which is the water resource consistency and got the following data. To evaluate this, the researcher has developed five scale points, which are excellent, very good, good, poor and very poor. Moreover, from the total respondents, 77% of the respondents are suffering from a problem of water unavailability when they go to use the shower or laundry in PSU. So there should be a solution whether to get any possible alternative water resource system or water storage system.

According to (National disability Authority, 2012) People with disabilities need in most cases separate rooms, equipped with additional space for wheelchair access, special handles, handrails, specialized devices mounted at appropriate heights and other amenities. In a large building or a small unit, it is worth providing the best accessible infrastructure units for the disabled both in the women and men's zone. As can be seen in figure 59, the researcher has tried to collect the physically challenged people and try to see if there is any consideration on the design of the PSU for them. 7% of the total respondents are physically challenged, However, on the design of the PSU, there is no consideration for them. And the researcher have tried to evaluate the unit based on the rate of the users on a scale of 5 like excellent, very good, good, poor and very poor. And get that 95% of the respondents think that the PSU did not give any consideration for the universality of the unit for physically challenged users. This shows us there is a problem for the accessibility of the whole public.

The last one the researcher try to know about the technical values of the PSU is about the economical affordability of PSU. In my onsite field observation, it is observed that the users pay 7 birr for using a shower on this sanitation unit, with a soap. Before going to the preference analysis of the users among affordability of PSU, it has been tried to see the income of the respondents. And find that from the total of 120 respondents, 38% of the respondents are farmers, 18% of the respondents are students, 17% of the respondents are labored, 8% of the respondents have no work, 7% of the respondents are merchants, 7% of the respondents are housewives, 3% of the respondents are employees, 2% of the respondents are Bajaj riders, 2% of the respondents are barbers. And from my field observation, it have been observed that there is no much cash in hand of the society since the farmers cultivate for their consumption.

After this, the researcher tried to give the respondents the question to rate the price to use the shower and laundry service in PSU. Nearly 82% think that the price is too high to afford to use a shower. Then the researcher try to see the maximum affordability preference of the respondents and found that the average money they can afford is 3 birr and even most of the respondents can afford 3 birr to pay for the service.

The researcher tries to find if the managerial factors affect the utilization rate of the PSU. And the researcher have tried to find the management performance in managing and controlling the PSU. Because the availability and the good organization of the project influences the usage frequency of the unit. So first, the researcher tried to find the availability of the manager or concerned body on the unit always and whether the users ever find it closed and left disappointed. For this question, the collected data is analyzed as follows. From the total respondents, 53% responded they have found it closed, 22% responded they always get it open and 31% responded I do not know. This is also another contributing factor to the underutilization of the sanitation unit.

Then the researcher tries to find how many times they got it closed for the ones that responded 'we find it closed'. And found that from the total 63 respondents, 62% find it closed 1-5 times, 17% find it closed 5-10 times, 8% find it closed 10-15 times and 13% find it closed more than 15 times. This shows us many users are suffering from the close up of PSU when they come to use any sanitation facility in the unit. Next, the researcher tries to see the feeling of comfortability when the users complain or voicing their concerns regarding the integrated sanitation unit (PSU). And found that 42 % of the total respondents to the question, they have problems raising their voice for the concerned management body. The researcher also tries to find if the management gives an immediate solution to the problems raised by the users. And found that 40% of the respondents have problems on getting an immediate response to the issues they have complained. This shows us there is a problem for the users to get an immediate response from the management on the issues they raised.

5.3. Interview data result & discussion

In this part interview with the current project management team was conducted and analyzed based on the response of the manager. The research in this interview aim to get an insight about the frequent users, reported complaints, hindering problems, demand and extent and project timely maintenance issues.

A. The manager of the infrastructure unit.

The manager of the infrastructure unit is inhabitant who is a permanent resident in Wurerber Kebele. His name is Rehik Musid, he is a merchant and Bajaj owner. In addition, for the sanitation unit he was responsible for managing the site.

The role of Rehik on the sanitation unit was first when the construction was undertaken, he was providing shelters for the workers, food, helping with taking care of the issues regarding the Kebele and taking part in organizing the works. Nowadays for the sanitation unit rehik is the one who is responsible for controlling. Cleaning and safeguarding the sanitation unit.

B. Necessity of the sanitation unit

For this question the manager responded in passion that, “since water is very essential for every human being, the project answers one of our crucial questions. Even the tap water gives a service for drinking water when there is a problem on the bono.”

C. The difference that the sanitation unit made from previous trend

The manager responded to this question that the sanitation unit has made a difference on the sanitation practice of the users. Since it creates a shade rather than washing outside on the river and the provision of clean water for the users, it made a clear difference.

D. Overall number of users reported

“There is no exact number of users since it differs from day to day and I have not recorded it.” However, from what the manager have experienced, there is a better usage frequency from Wednesday up to Sunday, on Monday and Tuesday there is a little or no users. The most number of users prefer the day Friday (Muslims) and Sunday (Christians) and this two days are the most busiest days when compared to the other days, still it is low but it is expected to have 5-7 users in these days. Most of the users of this unit are the adults, but the youths and the elderly usage of the sanitation unit is insignificant. The usage frequency of the married inhabitants is low and most of the users of the sanitation unit are the bachelors. The females usage frequency is

very low when compared to the male users. When the project was started, there were some female users but through time, the number becomes very low.

E. Frequently reported complaints

The most frequent complaints are the technical complaints. When there is a close up for maintenance, the users complain. There are problems regarding the plumbing system, the water wasted from the droplet problems, this happens many times. There is a water supply issue, there are users who complain about the water supply issue, and left back without using what they came for. There is an accessibility issue for the physically challenged users. There is also a problem of the shower usage; some users' leave it open and left without closing the water, and the water wasted. The other problem is the smell of the settlement tank on the waste treatment plant, when it is full the manager cleans it with a bucket and flush it on the surface. There are some people who complained to have a toilet and a security guard on the site for 24/7 accessibility of the sanitation unit. The laundry have issues of comfortability in the size, material sharp edges and the space placement.

F. Main problems hindering the sanitation unit

“In my opinion the main problems which are hindering the sanitation unit from growing are three issues, the first one is the water supply inconsistency, the second one is the cost which is asked to pay for the service is not affordable by most users and the last one is the spatial problems regarding unisex space.”

G. Maintenance of sanitation unit

The maintenance is made according to the issues arise, mostly the plumbing system fails and from the collected money from the users the manager will try to maintain the sanitation unit. The other thing which the manager does is to clean the settlement tank every Wednesdays.

H. Comments for improvement

“I would say the first thing to improve is to have a property line or a compound for better management and use, the next thing is the provision of a toilet for the users, since it is reported frequently by most of them. And if the waste treatment system is

improved basically the issues of overfilling on the settlement tank; and if there is a water storage system for the sanitation unit, the unit will become more convenient and comfortable.”

Discussion on the interview data

The manager of the infrastructure unit is inhabitant who is a permanent resident in Wurerber Kebele. His name is Rehik Musid, he is a merchant and Bajaj owner. And for the sanitation unit, he was responsible for managing the site. He was a part of organizing the team when the construction was conducted. He and his brother were among the pioneer inhabitants of Wurerber Kebele. Nowadays for the sanitation unit, Rehik is the one who is responsible for managing the unit and every Wednesdays he cleans and safeguarding the sanitation unit the whole annum. For the necessity of the infrastructure unit, he replied that water is very essential for every human being, so the project answers one of their crucial questions. Even the provision of tap water on the sanitation unit gives better service for drinking water demand for the inhabitants living nearby.

There is no exact number of users recorded since it differs from day to day and the manager did not record it. However, from what the manager has experienced, there is a better usage frequency from Wednesday up to Sunday, The most number of users prefer the day Friday (Muslims) and Sunday (Christians) and this two days are the busiest days when compared to the other days, still it is low but it is expected to have 5-7 users in these days. Most of the users of this unit are the adults, but the youths and the elderly usage of the sanitation unit are insignificant. The usage frequency of the married inhabitants is low and most of the users of the sanitation unit are the bachelors. The females' usage frequency is very low when compared to male users. When the project was started, there were some female users but through time, the number becomes very low. This is because the unit has not provided better privacy since most of the females in rural areas are shy to wash together or on exposed space. Main problems which are hindering the sanitation unit from growing in his experience on managing the unit are three issues, the first one is the water supply inconsistency, the second one is the cost which is asked to pay for the service is not affordable by most users and the last one is the spatial problems regarding unisex space.

Chapter Six: Conclusion & Recommendation

6.1. Conclusion

The researcher analyzed the existing realities on constructed PSU through taking a survey in Wurerber Kebele. The usage frequency of the constructed unit in Wurerber Kebele is compromised this is investigated based on the usage frequency of the sanitation unit, this derives because of geographical location, functional arrangement of the spaces, behavioral values of the unit, technical and managerial issues present on the sanitation unit. The water provision from the municipality is not enough and inconsistent for the users. The common sanitation trends in Wurerber are not clean and safe for usage except the privatized ones. The questionnaire survey result of the respondents shows that the usage of a shower in PSU is 38% from the total respondents and for the laundry; it reduces to 10 % of usage frequency. This implies that the usage of PSU in Wurerber is below the expected level.

On the way of investigating and optimizing the PSU in Wurerber Kebele users the researcher, triangulate results from literatures, case studies, observations from the existing realities, Questionnaire survey and interview. From these there are different options for water supply provision for the public sanitation unit rather than using the potable water directly from the municipality supply line; these are rainwater harvesting, ground water and surface water treatment & use. Among these, the ground water is a very promising water supply resource, since Wurerber is rich in ground water, which is why there are more than three water-bottling industries in the Kebele. The wastewater treatment for all the usage demands more space and financial resource both the treatment with infiltration and recycle will be the most effective approach, since the unit is suffering with overflow and dislodging the wastewater from the treatment settlement tank.

The PSU has served the community since 2017 and continuing to do so. From the data analyzed, it has been found that most of the users of the unit are the adults. The youths and the elderly usage of the sanitation unit is insignificant. The usage frequency of the married inhabitants is low and most of the users of the sanitation unit are the bachelors. The females' usage frequency is very low when compared to the male users. This is because of different behavioral factors. From the behavioral study, the researcher have found that more than 63 % of the respondents have problem in privacy and sense of security issues when they are using the unit, the spatial arrangement of the spaces, the

unisex problems of PSU and the movable partition are the contributing factors for the reduced number of usage frequency.

From the geographical findings, 52 % of the respondents live more than 500 meters from PSU. The implication from the geographical location of the PSU findings is that when the location is far from the living place of the users, the usage frequency decreases. Moreover, the researcher try to compare the distance of the river and the distance from the sanitation unit and found that nearly 67% of the respondents responded that the river is far from their living place, but they still prefer it for their sanitation needs. Therefore, what this can imply that there are other contributing factors for the reduced usage frequency of the built public sanitation unit. Then the research try to see other contributing factors, which are concluded as follows.

The Functional configuration finding leads the researcher to the conclusion that they are insignificantly used spaces in the PSU, like the waiting space and the laundry, which occupies 43% of the entire unit. This is because the user's preference of staying and washing in the outdoor environment rather than in enclosed space. In addition, the comfortability of the spaces have an impact on the usage of the unit. For instance, the laundry usage is low because of the space placement, the overall design of the space; the material and size of the sink were among the contributing factors from the data analyzed.

About 67% of the respondents are interested in social collectivity whether in washing their clothes with family or in friends rather than washing alone. The researcher try to find if the PSU fulfils the social needs of the community. In addition, some social spaces were investigated, which are expected on such kind of communal facilities and found that 85% of the users rate the unit "poor". Moreover, regarding the cost effectiveness of the unit, nearly 82% think that the price is too high to afford to use a service in the PSU. Therefore, the cost should embrace all the community capacity. According to the manager of the PSU, the main problems, which are hindering the sanitation unit from growing in his experience on managing the unit, are three issues. The first one is the water supply inconsistency, the second one is the cost, which is requested to pay for the service is not affordable by most users and the last one is the spatial problems of the unit.

The finding from the analysis result articulates the problem that is related with the topological and typological aspects of the unit, functional, technical, behavioral and

managerial issues are the pillars to have effect on the rate of utilization of PSU in Wurerber Kebele. This needs proper interventions in these values of the unit. The conclusion in this study falls in these major areas of the result and discussion. Underrating these elements the PSU could bring adverse impact on the usage frequency of the unit. Optimization of these values will increase the usage and at the same time the public acceptance of the PSU.

6.2. Recommendation

What the results in this thesis shows, in the first place is that in the design of any public service facilities, the user demand should be studied first and the user should be involved. In addition, a prior study should be made before designing and constructing the unit, the design should follow the advice design approach rather than command and construct. If the design variables were studied and analyzed before the construction of the unit, an optimized and publicly accepted sanitation unit will be constructed.

Before getting to the optimization of the values of the PSU, the researcher recommend on the awareness creation of the community of Wurerber about the need and necessity of the clean sanitation and its outcomes. Since one of the factor for the public acceptance of the unit is there should be an awareness creation from different stakeholders like the health center nearby since the catchment of the health center is for all of the Cheha Woreda, it will be easy for information dissemination. What the experience on the public acceptance of Holi water in Christianity religion tells us that for instance the awareness, which is created from the Church, gives the believers to go to the Tebel space to get rebirth from their respective God wherever it is located. This implies that the power of awareness for the people have a positive impact on the improved usage frequency of PSU.

Optimization of the problems on the topological, typological aspects of the PSU should give an overall zero derivative of problems. Therefore, in order to get a zero derivative of the problems which the researcher find from the research should be given solution. In addition, the functional, technical, behavioral and managerial values should be optimized based on the findings from the survey.

i. Recommendation on optimization of topological and typological distresses of PSU

The consequence of events depend on the topological characteristics of cities, which are the result of the particular growth process and geography of a place. Centrality is relevant for various spatial factors affecting human life and behaviors in cities. It is

found in this research that the catchment centrality have effect on the usage of the sanitation unit. The sites, which are in 1km radius, are more favorable and these are the most frequent users of the unit. Most of the respondents of PSU are not satisfied with the location of PSU from their living place, because they give the rating for the sanitation unit poor and very poor in the survey. What has been concluded from all this is that when the location is far from their living place the usage frequency decreases. Therefore the catchment must be as center as possible for all the users of the PSU.

On the spatial connectivity analysis, what the thesis have found is that there is no clear way to the sanitation unit. This creates low connectivity of the unit with the surrounding spaces. What it can be observed on the thesis is, the more the visible the unit is the more the user it will have. Therefore, when situating the PSU, there must have a clear line of way spatially and visually.

As observed on site, it is found that the showering culture differs in religion, culture and age group. In Muslim religion if a man washes, his body on some place the woman could not be allowed to wash on that place. This creates a low acceptance of the PSU in Wurerber since there is no unisex space, even if most of the inhabitants of the Kebele are Muslims. Both male & females prefer to have a fixed partition rather than open one. However, what has been observed on the built sanitation unit. Even the culture of washing clothes is on the outdoor environment rather than indoor. Therefore, before any design is implemented, the culture of the community with respect to the function of the design must be premeditated and contained within in the design. That is not seen in the PSU of Wurerber.

The sanitation unit is trying to fulfill all the water demand from the municipality supply line. The supply is inconsistent and taking the clean water from the drinking water. Since Wurerber is a pilot site it should also act accordingly in using alternate water source like ground water, treated grey water or rain water harvesting. If this was applied on the unit, it uses its own off grid water supply system and the cost requested for the service will be minimized. In addition, it creates a one-step for water sensitive urban development. In addition to wastewater treatment and infiltration system in PSU, the reuse of the treated wastewater must be taken as an alternative as water source. Therefore when designing the PSU the water sensitivity must be taken as a main design parameter.

ii. Recommendation on Optimization of behavioral values of PSU

The user will decide whether he uses the built unit or not, for this reason the behavioral aspects of the PSU should be premeditated. The overall satisfaction of the users is less than expected in the PSU of Wurber. This comes due to different reasons, from this the behavioral factors like decreased quality of privacy and sense of security are the contributing ones. Therefore, the PSU must have a safe and a quality of expected privacy.

Regarding the trend of washing clothes environment like indoor washing, outdoor washing or anywhere may be also the factor for not using the laundry in the enclosed space in the PSU. And the collected data show us most of the respondents prefer washing their clothes in outdoor environment. So this is also the contributing factor for the low PSU laundry usage. From the analysis findings of the data, which the research got on the sociality preference for using laundry, the majority of respondents are interested in social collectivity whether in family or in friends for washing their clothes. Therefore, the design of PSU must incorporate a quality of sociality collective usage and the washing space should be designed outdoor with a proper shading.

iii. Recommendation on Optimization of functional arrangement values of PSU

The functional aspects of PSU are the contributing factors for the underutilization of the sanitation unit. For the comfortability of the partition space, most of the users are not comfortable on the partition space and material. Therefore, for the design of PSU the space provided for the shower partition must be comfortable, the material for the partition should be a fixed rather than movable plastic and when fixing the appliances, the reachability of the users must be taken as consideration. Since one of the functional space in PSU is waiting space, the researcher try to find whether the designed and provided space is necessary for the respondents. Majority of the users prefer to wait outside. This shows there is no need of the waiting space in the interior spaces. The waiting space must be placed outside.

Also the researcher try to collect data if any functional spaces is to be added what it should be, and found that majority of the respondents need a toilet, carwash, water park, compound, coffee and tea spot, outdoor shade and parking to be added on PSU. In addition, the paper tried to find if the PSU fulfils the social needs of the community.

And the researcher have put some social spaces which are expected on such kind of communal facilities like availability for old and disabled people, composition of recreational grounds for children and adults, composition of playgrounds and greenery. First the researcher have tried to give the respondents to make a rating if there is any, and for all of them more than 85% responded that the composition of these social spaces are very poor. Since the PSU is designed for the general public the design of PSU must incorporate spaces which fulfils the social needs of the community as a whole.

iv. Recommendation on Optimization of Technical values of PSU

The specific details regarding the project are the contributing factors for the lower utilization of the PSU. The laundry comfortability, water supply consistency, price and universality of the PSU are among the prominent ones. First, the researcher tried to find why the respondents are not using the laundry and the frequency of the usage of the shower unit. 85% responded the laundry is not comfortable that is why they are not using the unit. Majority of the respondents replied that there is a problem on the laundry space, barrel size, barrel material and the overall barrel design. This is a contributing factor for under usage of the laundry in the public sanitation unit in Wurerber Kebele. Therefore, the design of the laundry must take care of this issues for a better usage of PSU. Most of the respondents are suffering on a problem of water in availability when they go to use the shower or laundry in PSU. So there should be a solution whether to get any possible alternative water resource system or water storage system in PSU.

The researcher have tried to collect the perspective of the physically challenged people in the community and try to see if there is any consideration on the design of the PSU for them. 7% of the total respondents are physically challenged, However, on the design of the PSU there is no consideration for them. And the research have tried to evaluate the unit based on the rate of the users on scale of 5 like excellent, very good, good, poor and very poor. And get that 95% of the respondents think that the PSU did not give any consideration for universality of the unit for physically challenged users. This show us there is a problem for the accessibility of the whole public. Therefore, the design of PSU should comply with guidelines of universality matters.

From the survey, the other contributing factor for the lower utilization of PSU is the economical affordability of PSU. In the onsite field observation, it is observed that the users pay 7 birr for using a shower on this sanitation unit, with a soap, even if the majority of the inhabitants of Wurerber are farmers. From the survey to rate the price to use the shower and laundry service in PSU, Nearly 82% think that the price is too high to afford to use a shower. Then the researcher try to see the maximum affordability preference of the respondents and found that the average money they can afford is 3 birr to pay for the service. Therefore, the researcher recommend making the service charge 3 birr, and if possible freeing.

v. Recommendation on Optimization of managerial values of PSU

Since the availability and the good organization of the project will have an influence on the usage frequency of the unit, the researcher try to observe the quality of the current management body. So first, the researcher tries to find the availability of the manager or concerned body on the unit always and whether the users ever find it closed and left disappointed. Moreover, found that more than half of the respondents find the PSU closed and left home without using services. This decreases the public acceptance of the PSU; therefore, the unit must be open 24/7 as much as possible.

The other contributing factor for the managerial performance survey is the feeling of comfortability when the users complain or voicing their concerns regarding the public sanitation unit (PSU). And found that 42 % of the total respondents to the question, they have problems on raising their voice for the concerned management body and on getting immediate response for the issues they have complained. This show us there is a problem for the users to comfortably raise complaints and get an immediate response from the management on the issues they raised. Therefore the concerned managerial server should give a proper and quick response for the public in order to make the PSU publicly accepted unit.

6.3. Sanitation unit Design guideline

Recommendation on the guideline for the design of the sanitation unit in rural areas:

The following are the design guidelines, which could be adopted for the design of a sanitation unit, which is designed to be constructed in rural areas.

- I. PSU site should be located centrally to the inhabitants living place. What have been concluded in the study specifically in Wurerber shows the possible end-users of the unit are the inhabitants, which are living in not more than 1km radius from the sanitation unit. Therefore, the PSU should be located as central as possible.
- II. The site should be developed incrementally, through the addition of social spaces for all age groups. By following the development of the unit, the spaces should be added according to the study made prior to the design and construction of the unit.
- III. Shower space should have fixed partition, apt sense of security, should be unisex and universal user friendly. This means that ensuring accessibility for users of all ages and physical abilities.
- IV. Laundry space should be provided outdoor with shade from adverse climatic conditions. It should have standardized size and design. The culture in most of the Ethiopian rural areas is for washing most people's prefer the outdoor environment, rather than in the interior spaces. The study in Wurerber shows also this.
- V. Waiting space should be located outdoor. As observed in the case pf Wurerber, the users prefer to stay outside enjoying the views rather than waiting in the interior spaces.
- VI. Toilet or WC should be incorporated with the PSU. From most of the respondents, response in the study shows there is a high demand of a toilet to be incorporated in the design pf a PSU.
- VII. For the provision of the public sanitation units, the population number and the demand analysis should be made prior to the design of the unit. In the case of Wurerber specifically, at least 10 shower and 12 laundry lots should be incorporated, if two PSU are planned to be constructed as centrally located as possible for all the users.

- VIII. The PSU should satisfy its water demand by its own resources like ground water and rainwater harvesting, without using a potable water from municipality. Since the unit needs more water and as a focal point for the public, the unit should give a lesson for the community about the water conservation and efficiency to be adopted in a single household or a community level. Therefore, the unit should use an off-grid water supply as much as possible.
- IX. The PSU should have its own wastewater treatment and infiltration system, since there is a high effluent from both showering and laundry. As a lesson for the community and also since there is a high effluent from the unit, it should have a system that can reuse to the system or infiltrate, what it have already taken water from the ground, to the ground.
- X. The construction system should minimize its carbon footprint, so the PSU should be constructed with the local construction material, system and worker, to make it cost efficient, sustainable and for creation of a sense of belongingness.

6.4. Design proposal

6.4. Design Proposal Scheme

The design proposal of this unit passes different steps the first unit is the Project inception the next step is based on the inception the space Programming is conducted. Then Site planning takes place. After this, the sanitation Unit spatial Design and guiding the unit towards Self-efficiency takes place.

A. Geographical location scheme

The proposal is made using the findings from the conducted thesis. The geographical findings, functional findings, technical findings have been taken as the tools for the design. From the geographical findings since most of the respondents of this thesis responded the PSU is far from their living place the first step is to make the unit as central as possible. Therefore, as it is recommended the PSU must be located at a radius of 1km from the living places of the users, since the potential users from the findings shows us are from less than this distance. As it is illustrated in the following figure, the unit must be placed on the two spots pointed.

B. Project Inception

Before going to the details the project inception should be predefined first. Project inception aims in defining the way towards the development of the unit becoming a public integrated facility unit.

The first step for the design should be defining the water supply resource therefore in the proposal the water resource is planned to be from the ground water. First ground water wells should be installed. This will be phase 1 and the next step is constructing the sanitation unit, and this will be in phase 2 and in phase 3 the sporting activities will be installed, this will gather some peoples for sport in the unit. Shades and store construction will be done in this phase of the development. After sport, there will be users of the showering or laundry. Moreover, after showering there may be a demand for the food and drink, therefore small shops or shades will be constructed, this will be phase 4. The next phase will be constructing other public facilities like library, public multipurpose hall or parking.

The expected users of the PSU are estimated as follows. If the time that takes for the shower taking is estimated to be 20 minutes and per day that specific unit will be used by 36 peoples. Cumulative will be in a week 252-usage frequency. When it is calculated, based on the findings the shower trend is twice a week and 83 % demand moreover the total population of the Wurerber Kebele is 2621, from these the total demand of the unit for showering becomes 4350 times. So when divided by the weekly capacity of the unit, there should be a total of 18 shower lots needed. If nine units are constructed per a sanitation unit, 2 sanitation units are needed for the whole Wurerber Kebele. For the special needs or physically challenged a unit must be incorporated in the design. In addition, for the laundry the laundry trend is once per month and 83% demand, therefore 543 users. Per day one laundry, lot is used for 2 persons and per week 14 times. Therefore when the total divided by the unit capacity, 12 laundry lots are needed for one unit.

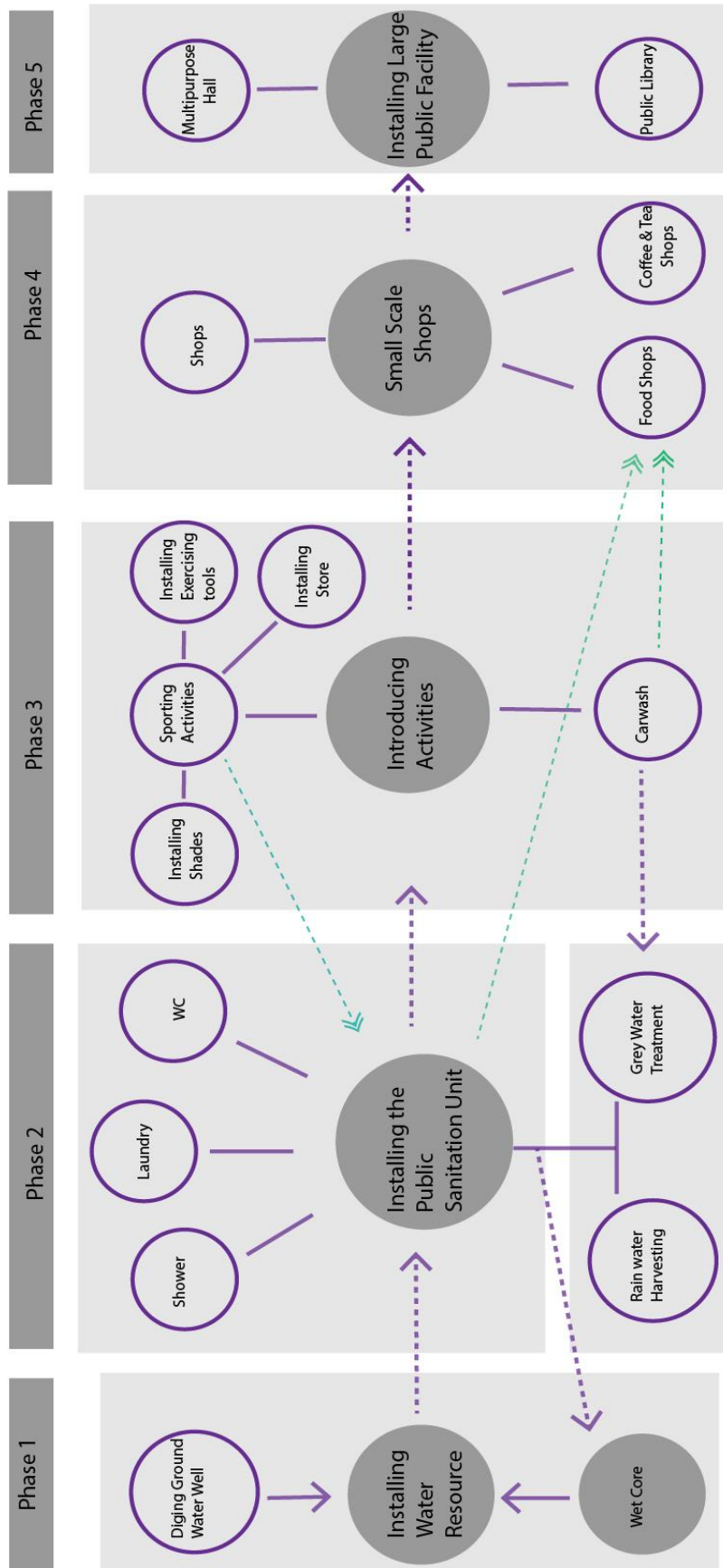


Figure 72 PSU Proposed Phased development.

C. Programming and functional arrangement

The spatial programs that should be incorporated in the design of this Public Sanitation unit are illustrated in the following figure; the programs are taken from the preferences of the respondents in this thesis. Then the area of these programs are adopted from the standards as Neufert architects data and personal projections.

From the findings in order to make the unit, more functioning the proposal incorporated other public spaces that should bring the inhabitants for other supportive functions like sporting activities. This could make the unit more active there for the unit becomes a “shower + sporting”.

The functions to be incorporated are unisex shower, unisex toilet, outdoor laundry with a shade, sporting facilities, car wash, outdoor waiting space, sitting places and protected green area. The research have projected these programs for the better usage of the sanitation unit.

Table 12 Functional programming

Phase	Spatial program		Quantity	Area M ²	Size	Placement
1	Ground water well		1			Outdoor
2	Shower	Male	4	3	2*1.5	Indoor, most private
		Female	4	3	2*1.5	Indoor, most private
		Elderly & Physically challenged	2	4	2*2	Indoor, most private
	Water closet/WC	Male	2	1.5	1.5*1.5	Indoor, most private
		Female	2	1.5	1.5*1.5	Indoor, most private
	Laundry		12	1	1*1	Outdoor, public
	Greywater treatment					Outdoor, public
Protected green area			Throughout the compound unbuilt area			

3	Sporting facilities	Exercises	Futsal	1			Outdoor, public
			Dig up	2			
			Pull up	2			
			Sit up	Anywhere in the compound			
	Shade					Semi outdoor	
Material store		1			Indoor		
	waiting space		Providing sitting places				Outdoor
	Car wash		1				Outdoor
4	Small scale shops	Shops					Indoor
		Canteen					Semi outdoor
		Coffee & Tea spot					Semi outdoor
5	Installing large public facilities	Library					
		Public Hall					

Functional arrangement

The spatial arrangement follows the incremental development focusing on developing a single public sanitation unit into an integrated community center. The spaces are added based on the finding from the research and in the sense of making the unit more public space rather than single purpose unit. The interior functional arrangement of the unit focuses on segregation of spaces for the case of privacy and sense of security. The toilet is accessed on the outside of the unit, because anyone who is in the unit for other activity can use it without influencing the shower users' privacy. The shower spaces have different size according to the standard of Neufert and personal onsite investigation. The space is arranged with the principle of ease of access, transition space and privacy and sense of security.

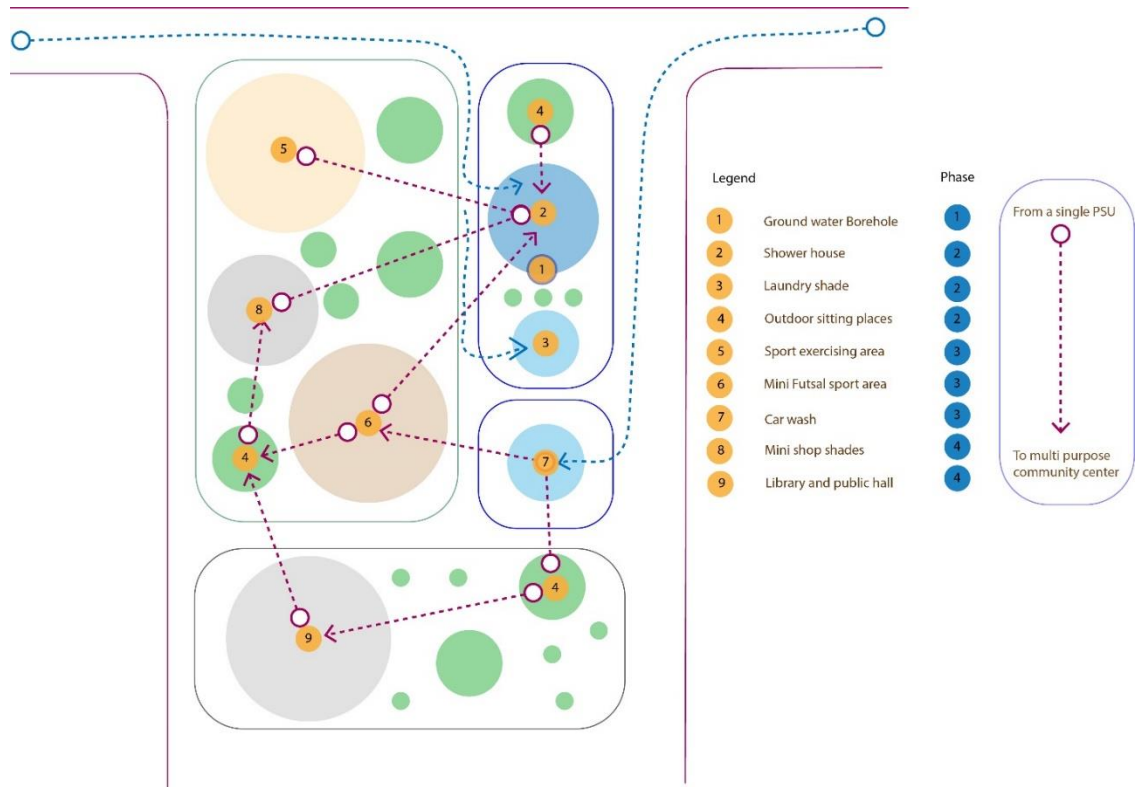


Figure 73 Proposed Functional arrangement



Figure 74 Proposed Overall site Phased development



Figure 75 PSU Proposed Floor plan.

D. Water demand & supply scheme

Although the exact moment of water use is normally unpredictable, it is well known that there are some periods of the day when it happens more frequently. For most people

this is in the morning after they wake up, in the afternoon when they return from work or school or in the evening before they go to sleep.

However, considering the findings from the research, the total expected users are 24 per day, with a 20 minutes shower taking time. The flow time for a single use is estimated to flow for 5 minutes in 2 GPM flow rate. This yields around 408 M³ water demand for shower usage in the PSU.

Table 13 Shower water demand

Usage Demand	Consumption per single use			Expected number of users				Total demand
	Flow time/Single use	Flow rate	Total flow	units	Single usage time	Per day	Total frequency per day	Per month
Shower	10 min	1 GPM	10 G	10	20 minutes	36 times	36*10=360	10G*360*30=108,000G or 408 M ³

Table 14 Laundry water demand

Usage demand	Estimated water demand per single use	No. of units	Usage frequency per day	Total demand per day	Total demand per month
laundry	40-60 L	12	2 times	50L*12*2=1200 L	1200L*30=36000 L or 36 M ³

Therefore, the total water demand for the PSU becomes around 444 M³ per month. When multiplied in a year around 5328 M³. This paper proposes to fulfill this demand from the ground water well and rain water harvesting without using water from the municipality. So first, the rainwater capacity of the unit had been assessed and then the rest demand is aimed to be fulfilled from the ground water well.

Rainwater harvesting

Estimating the amount of water that can be harvested in a given area depends on the catchment area, rainfall, system efficiency, and a design safety factor. The interpretation of each of these essential variables directly effects the planner's estimation. A simple estimate of the number of gallons that can be harvested from a given catchment area from a rainfall event can be determined with the following formula. The total number of gallons harvested is equal to the catchment area (square feet) times the depth of a rainfall (inches) times a conversion factor of 0.623.

$$\text{Harvested water (gal)} = \text{catchment area (ft}^2\text{)} \times \text{depth} \times 0.623 \times \text{R.C} \times \text{S.F}$$

The total harvested water is calculated after getting the rainfall data of the surrounding area. Since the researcher could not find the rainfall data of Wurerber specifically, it is taken the approximate data from the surrounding areas. It is found that the rainfall data of Gubre, which is 9 km from Wurerber Kebele. So as shown in the following table the average precipitation of the area is 102 mm. The variation in the precipitation between the driest and wettest months is 233 mm. throughout the year; temperatures vary by 2.8 °C.

Table 15 Rainfall data of Gubre

Rain fall data of Gubre, Ethiopia												
Month	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall	22	37	76	80	126	170	233	245	157	48	15	12
Average rainfall of Gubre = 102mm												

Source: Climatedata.org

When it is calculated from the formula above and taking the run off coefficient of metal from (Haan et al.,1994) & (Waterfall, 1998)., 0.95 and a safety factor of 0.8. The total monthly potential is presented as follows. From these the annual potential of the designed PSU becomes 97,702 mm. this means that 97 M³ water can be gained from the rainwater harvest.

Table 16 Average monthly potential calculation

Month	monthly average rainfall	catchment footprint	conversion factor	Runoff coefficient	Safety factor	Monthly potential
January	22	169	0.623	0.95	0.8	1760.399
February	37	169	0.623	0.95	0.8	2960.67
March	76	169	0.623	0.95	0.8	6081.377
April	80	169	0.623	0.95	0.8	6401.45
May	126	169	0.623	0.95	0.8	10082.28
June	170	169	0.623	0.95	0.8	13603.08
July	233	169	0.623	0.95	0.8	18644.22
August	245	169	0.623	0.95	0.8	19604.44
September	157	169	0.623	0.95	0.8	12562.84
October	48	169	0.623	0.95	0.8	3840.87
November	15	169	0.623	0.95	0.8	1200.272
December	12	169	0.623	0.95	0.8	960.2174
Annual						97702.12

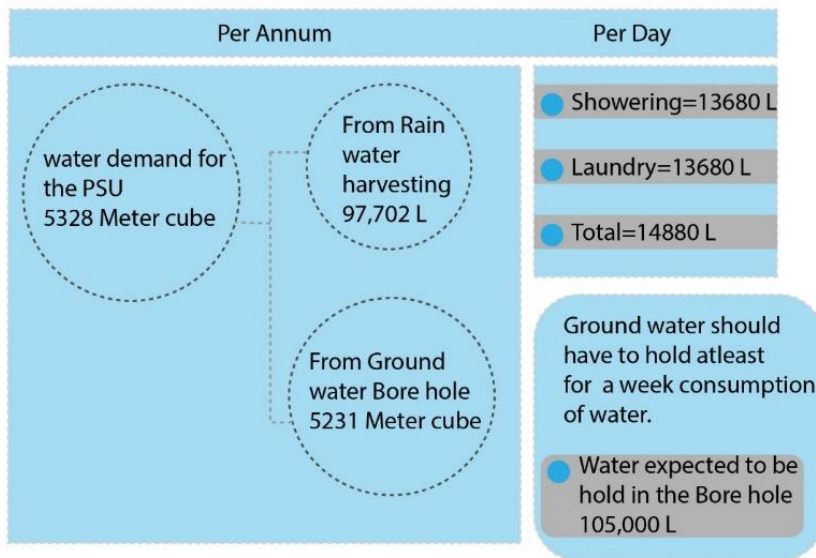


Figure 76 Projected Water demand

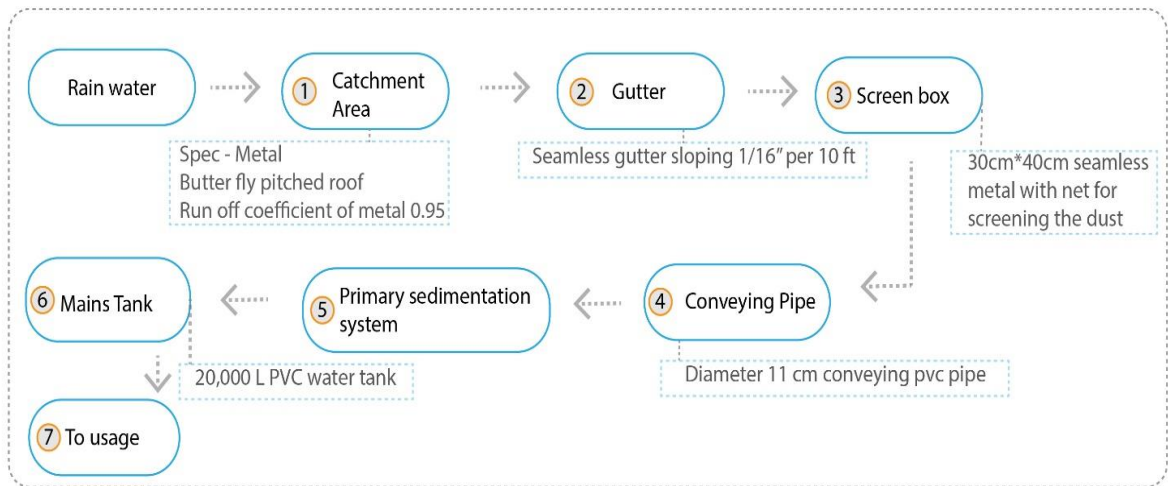


Figure 77 Proposed Rainwater harvesting flow chart

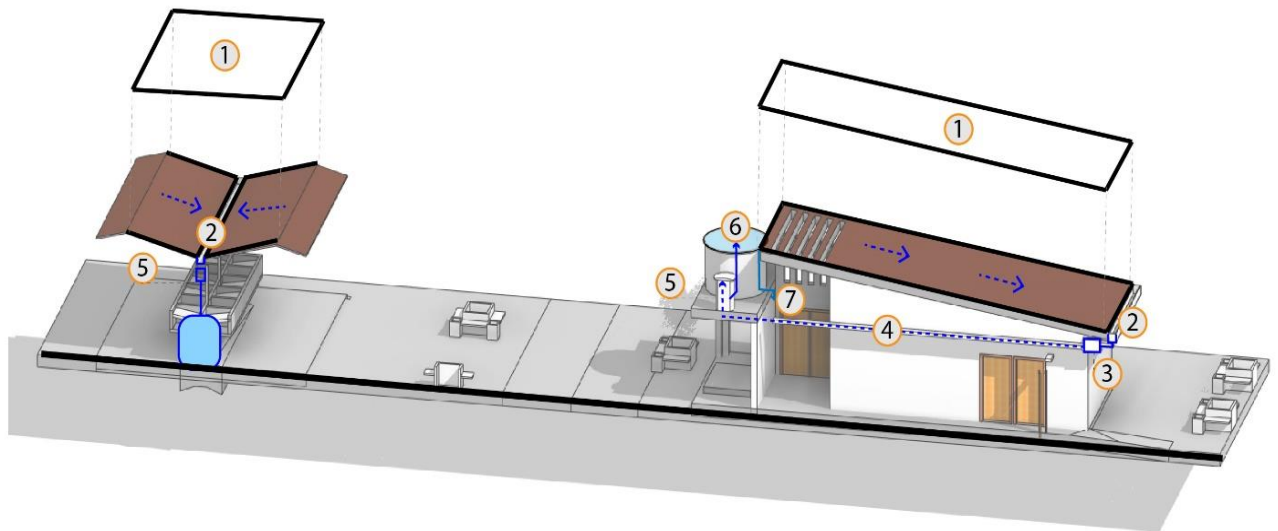


Figure 78 Proposed Rainwater harvesting diagram

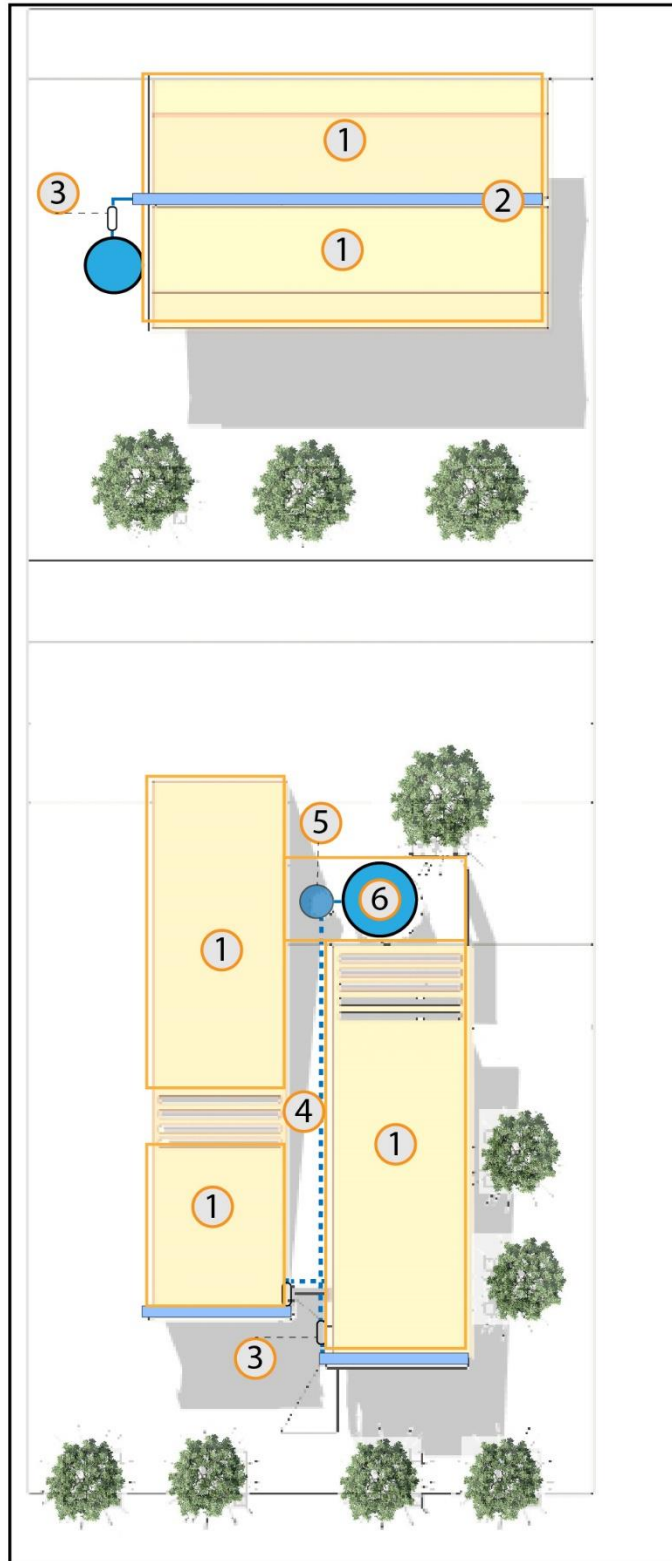


Figure 79 Proposed Rainwater harvesting plan view

Ground water bore hall

With rising utility costs and water bills, installing a borehole is fast becoming a viable way to obtain ‘cheaper’ water for many people. Depending on water usage, boreholes are capable of generating a rapid investment payback, often-cutting costs by up to 80% over metered mains supply. A borehole is basically a narrow vertical shaft bored in the ground. Boreholes are an effective way of tapping into the water bearing aquifer below the ground and pumping the water to the surface. Boreholes for extracting water consist essentially of a vertically drilled shaft, a strong lining (casing) to prevent collapse of the walls, which includes a means of allowing clean water to enter the borehole space (screen), surface protection, and a means of extracting water. (Oyebode, Oyegoke, Olowe, Onoh, & Adebayo, 2015)

In this research the proposal of designing the ground borehole uses a case study from one of the unicef standard for zimbabwe borehole construction. (UNICEF, 2012) As illustrated in the figure below, the process follows the way from the bore hole to the rope pulley pump then it is stored in the water mains. The collected water then is directed to the individual shower units and to the laundry with a conveying pipe. Then after, waste water will be collected, treated and infiltrated.

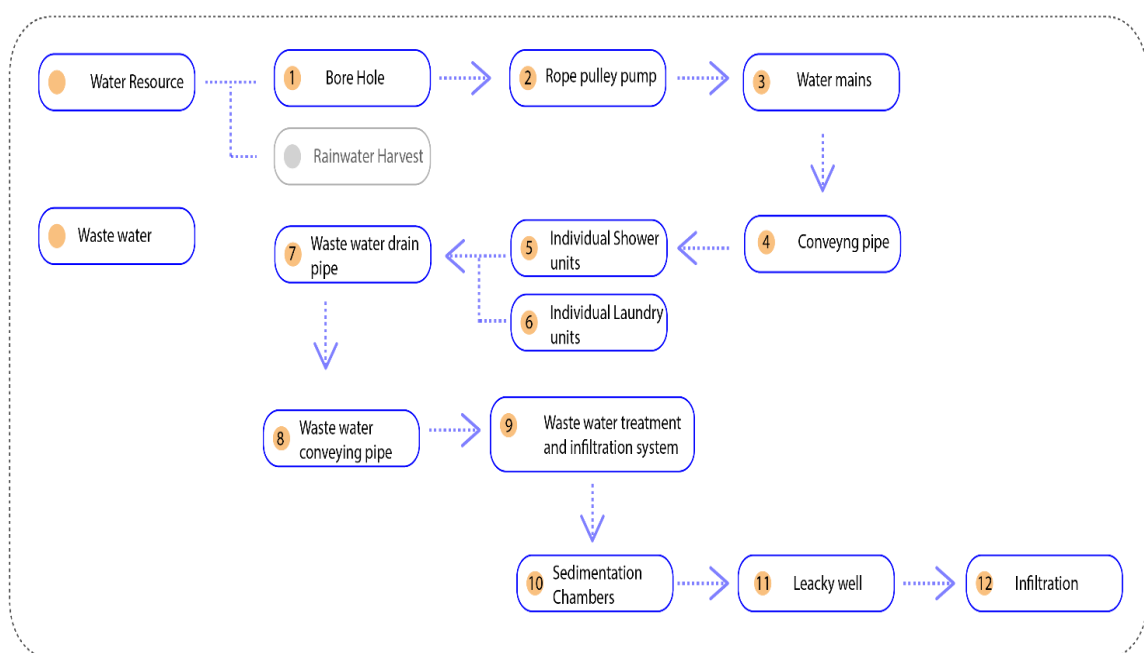


Figure 80 Proposed Ground water borehole water supply flow chart

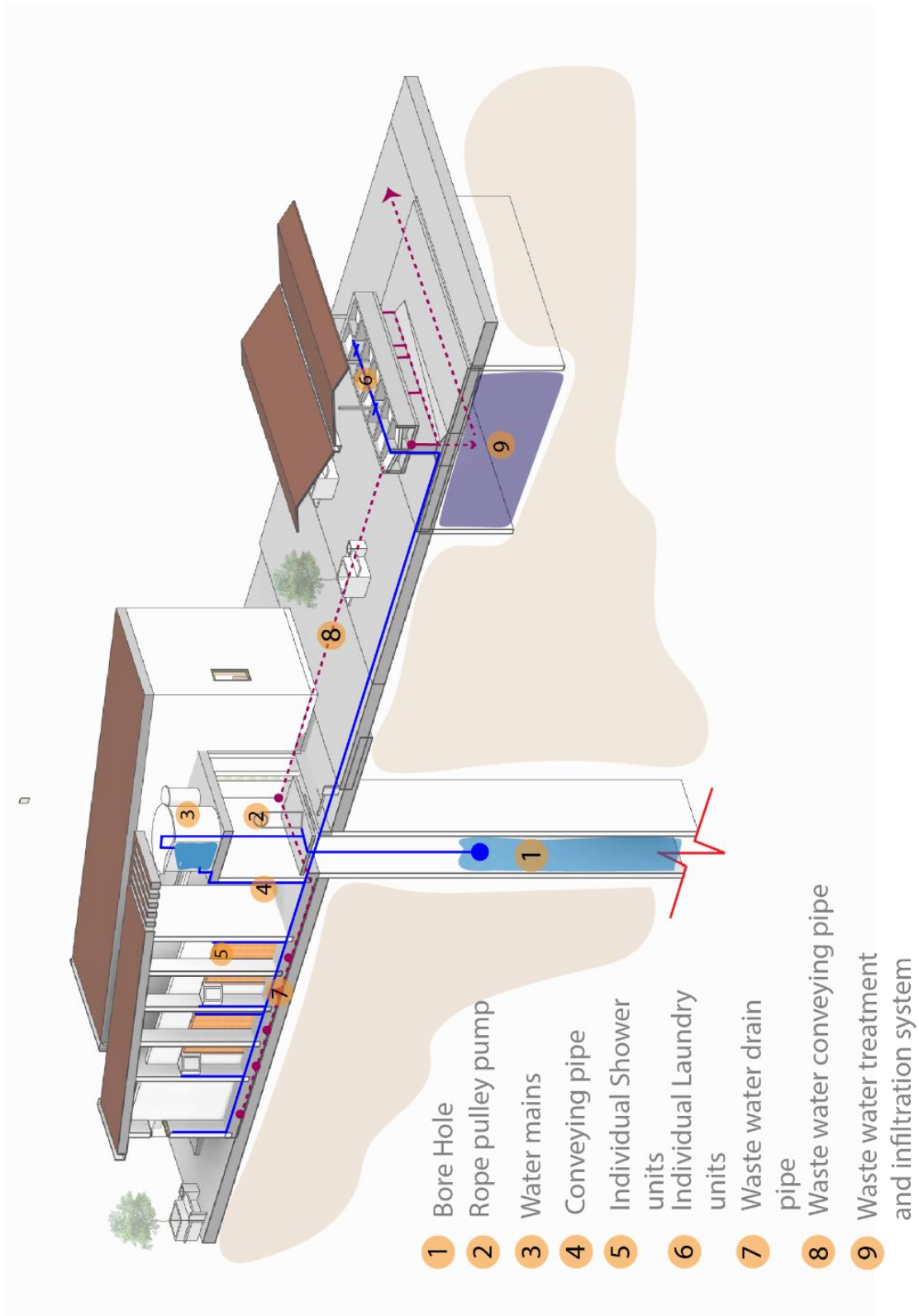


Figure 81 Proposed Ground water borehole and water supply system

E. Grey water treatment scheme

In this research Anaerobic baffled reactor (ABR) is used as a waste treatment and infiltration because it is resistant to organic and hydraulic shock loads, there is no electrical energy required, Greywater can be managed concurrently, Can be built and repaired with locally available materials. It have long service life, no real problems with flies or odors if used correctly, there is high reduction of organics, moderate capital costs, moderate operating costs depending on emptying; can be low cost depending on number of users.

An ABR can be designed for a single house or a group of houses that are using a considerable amount of water for clothes washing, showering, and toilet flushing. It is mostly appropriate if water use and supply of wastewater are relatively constant. The process is illustrated as follows.

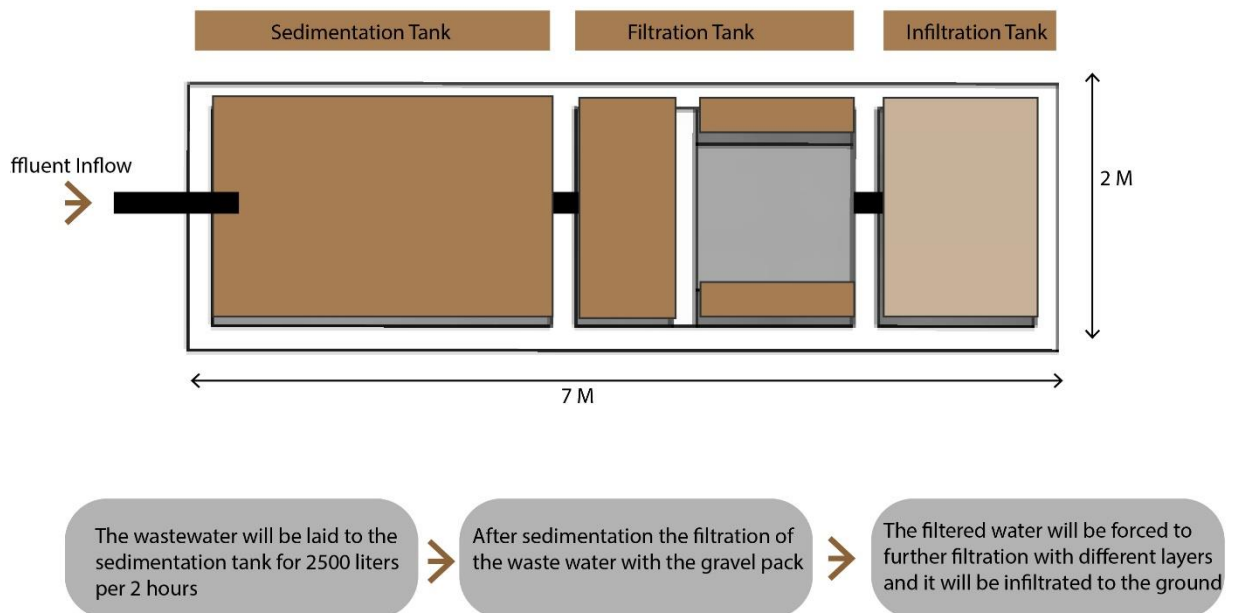


Figure 82 Proposed Greywater treatment scheme

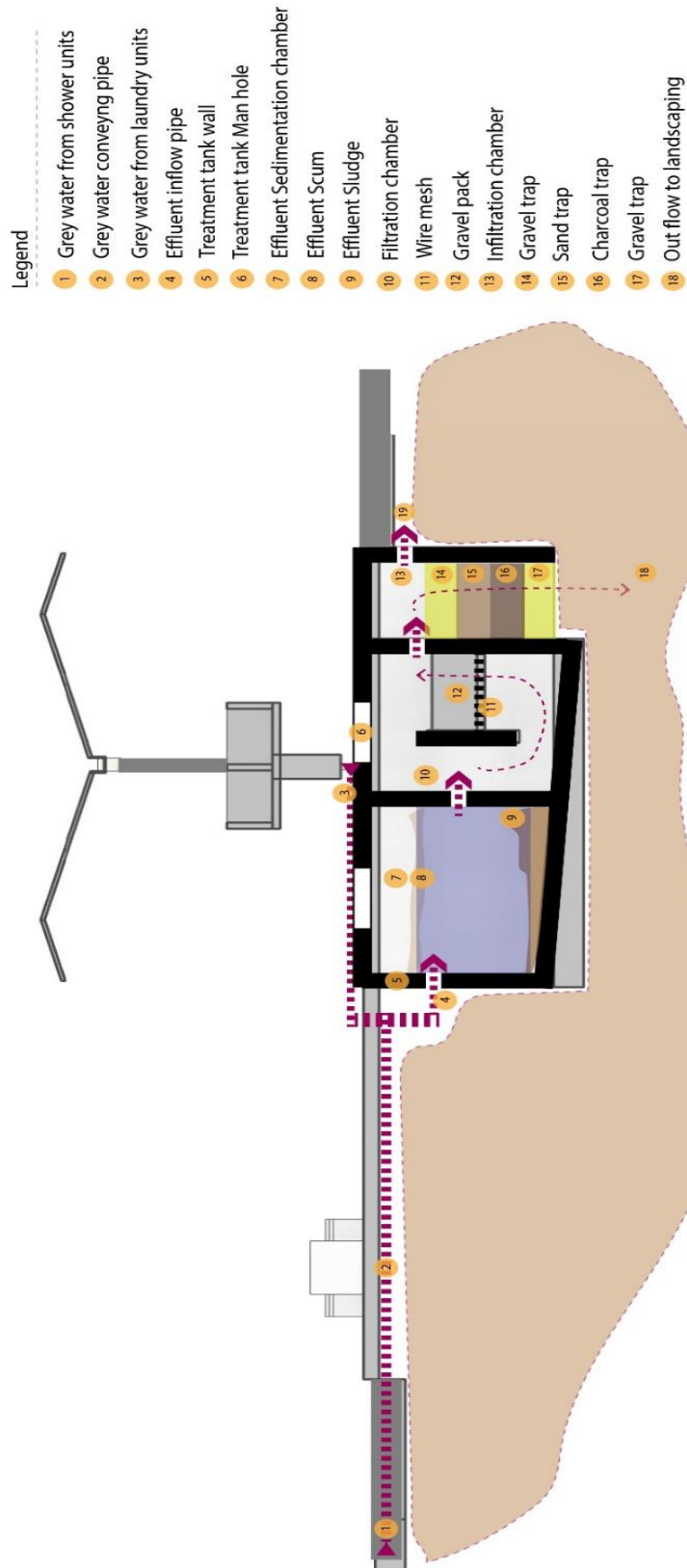


Figure 83 Proposed Grey water treatment system diagram

F. Construction system scheme

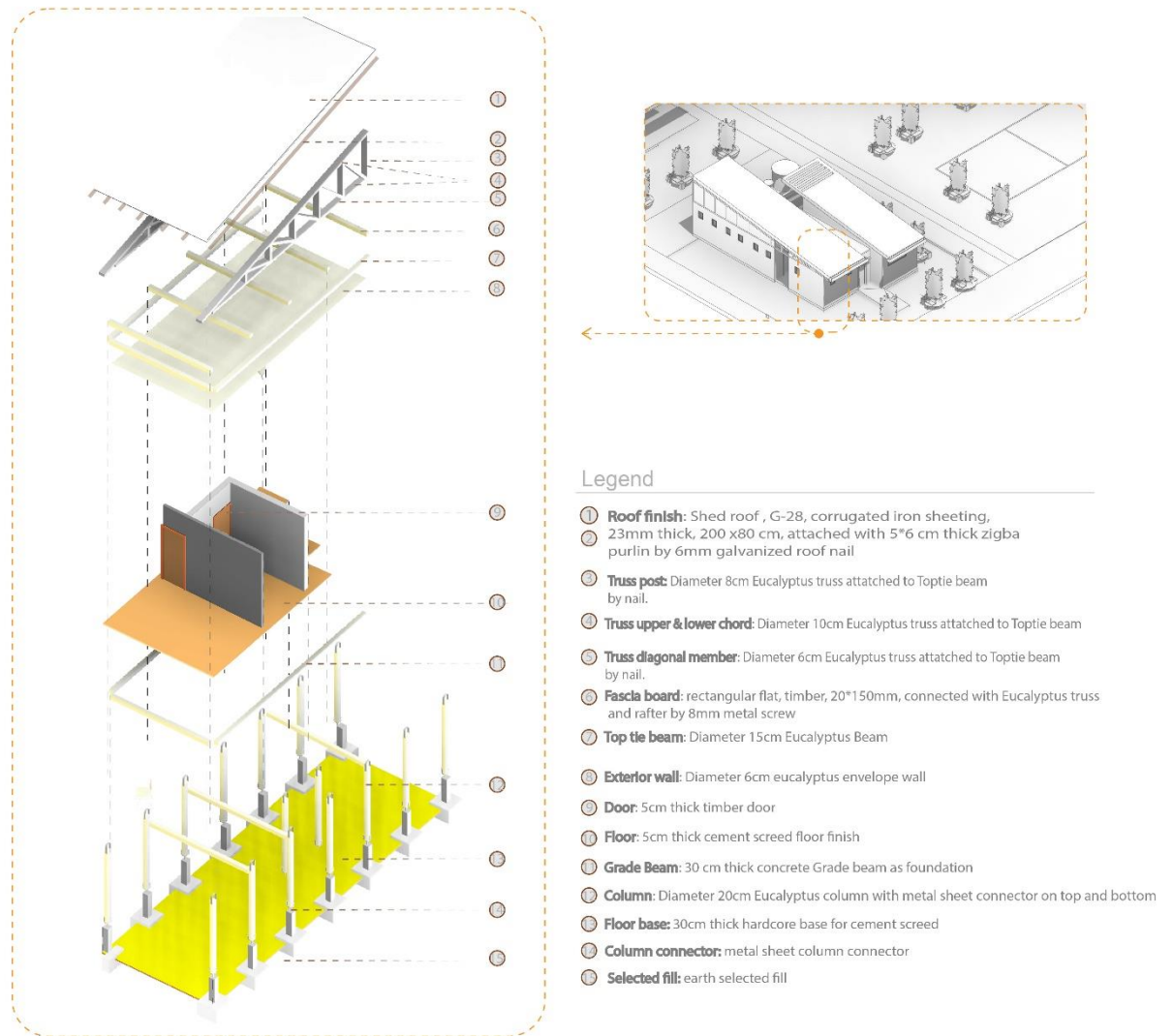


Figure 84 Proposed PSU Construction system

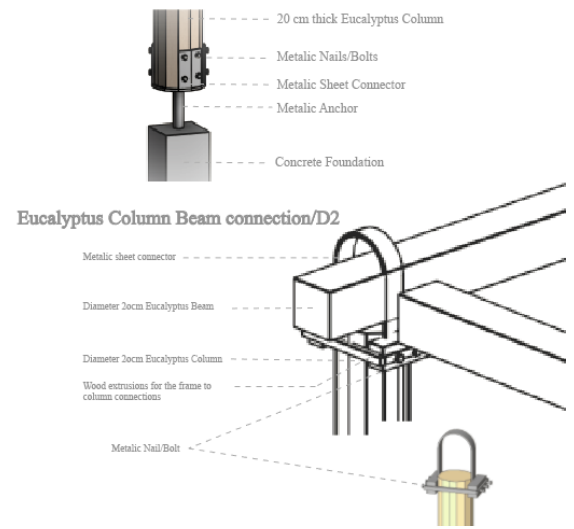
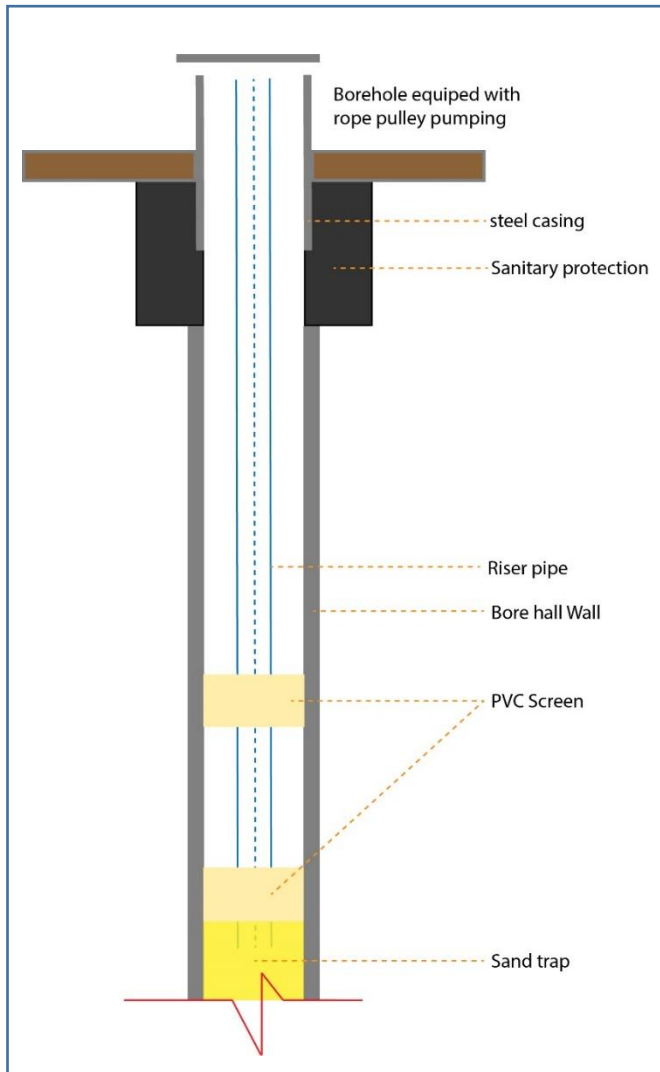


Figure 85 Proposed Column beam connection system.

Figure 86 Proposed Borehole construction detail. Source: adopted from (UNICEF 2012)

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Appendix

Appendix 1: Support letter from the Post-graduate program for conduction of the research.



Appendix 2: Questionnaire survey

Addis Ababa University

Ethiopian Institute of Architecture,

Building construction and City development

School of graduate studies



EiABC

Ethiopian Institute of Architecture,
Building Construction and City Development
የኢትዮጵያ ልማት ትምህርት ህዝብ ግንባታ እና ከተማ ልማት ተቋም
Addis Ababa University
አዲስ አበባ ዩኒቨርሲቲ

Research site: Region..... Zone Woreda
..... Kebele..... Village.....

1. Questionnaire survey for conduction of MSc. Thesis research

Target Groups: This questionnaire will be provided for the local peoples living in or near Wurerber village who are the direct users of the infrastructure unit. These are the permanent residents of Wurerber village, temporary workers live in Wurerber, users from nearby villages (yefeterek, wesherbe...) and visitors feeling and thought about the IIU will be collected in this survey.

a) Demographic Information

Demographic information from the residents and users of IIU such as Name, Sex, Age, Religion and living conditions data will be collected.

Full NameSex

.....

AgeReligionLiving
condition

.....

Ser. No	Name of family member	sex	Age	Educational level	Marital status of household head	Physical condition	Means of income
1							
2							
3							
4							
5							

b) For Demand survey

On this demand survey, the researcher will try to collect data about the need of that infrastructure unit in the first place. The demand and supply provision will be recorded according to the perspective of the users.

1. Do you use a shower in this infrastructure unit?

Yes

No

2. Do you use a laundry in this infrastructure unit?

Yes

No

Once

Twice

3 Times

4 Times

Everyday

3. How often do you use a shower per week?

4. How often do you use laundry per month?

Once

Twice

3 Times

4 Times

Everyday

5. Before this unit have been built, where do you use a shower?

River	Home	Other place
-------	------	-------------

River	Home	Other place
-------	------	-------------

6. Before this unit have been built, where do you wash your clothes?

7. Do you think that this infrastructure unit is mandatory?

Yes	No	I don't know
-----	----	--------------

c) For Spatial quality survey

i. Geographical aspect survey

Location of the infrastructure unit may not be desirable

8. Where do you reside?

Wurerber	Wesherbe	Yefeterek
Visitor	Other place	

9. Is the infrastructure unit near to your place?

Yes	No	I don't know
-----	----	--------------

10. How far is your living place from the unit?

20-50M	50-100M	100M-200M	200-500M	>500M
--------	---------	-----------	----------	-------

11. How far is your living place from the river?

20-50M	50-100M	100M-200M	200-500M	>500M
--------	---------	-----------	----------	-------

12. How would you rate the location of the IIU from your living place?

- Excellent
- Great
- Good
- Okay
- Poor
- Very poor

ii. Behavioral aspect survey

13. Is the unit attractive? Yes No I don't know

14. Does it meet your expectation? Yes No I don't know

If yes, How well?

- Extremely well
- Somewhat well
- Not at all well
- Very well
- Not so well

15. Does it satisfy the need for sense of security? Yes No I don't know

16. Did it meet your need in terms of lighting quality?

Yes No I don't know

17. Have you encountered problems in terms of Privacy specifically when you take shower?

Yes No I don't know

18. How do you wash your cloth?

Alone With friends With Family

19. What do you prefer on the environment of washing clothes?

Out door Indoor Anywhere

20. When do you use a shower most of the time?

Morning
 Afternoon
 Evening

Why?

iii. Functional aspect survey

21. Have you encountered any circulation problems in the IIU?

Yes
 No
 I don't know

22. Do you think that the Partition space is comfortable for showering?

Yes
 No
 I don't know

23. What do you prefer from waiting inside and seating on outdoor?

Waiting inside
 Waiting outdoor

24. What should be added in the infrastructure unit to make you comfortable?

Outdoor shade
 Toilet
 Parking
 Other (please specify)

Coffee & Tea spot

25. How is the unit acting in the way of implementing the Social needs of the users?

- Please place your mark on the boxes (X)

	Excellent	Good	Fair	Poor	Very poor
Composition of greenery					
composition of playgrounds					
Composition of recreation grounds for children and adults					
Availability for old and disabled people					

iv. Technical aspect survey

26. Is the Laundry comfortable for washing? Yes No I don't know

- If your answer is no, why it is not comfortable?

Laundry space

Barrel size `

Barrel material

Barrel Design

Other (please specify)

-
-
-

27. How do you rate the water resource consistency?

Excellent Very good Good Poor Very poor

28. What do you need for residing in wurer other than infrastructure?

Work opportunity Housing Other (please specify).....
.....:

29. If the listed problems have given solution, will you use the IIU?

Yes No I don't know

30. Are you physically challenged? Yes No

- If yes, how do you rate the universality of the built IIU?

Excellent Very good Good Poor Very poor

31. What do you think about the price to use the IIU?

Excellent Very good Good Poor Very poor

If it is not fair, how much should it be?

d) Management performance survey

32. When you come to use the IIU, do you ever find it not available?

Yes	No	I don't know
-----	----	--------------

• If yes, how many times?

- None
- 1-5 times
- 5-10 times
- 10-15 times
- >15 times

33. How comfortable do you feel voicing your concerns to the manager of the IIU?

- Extremely comfortable
- Very comfortable
- Somewhat comfortable
- Not so comfortable
- Not at all comfortable

34. Does the management gives you a solution to your problem immediately?

Yes	No	I don't know
-----	----	--------------

Appendix 3: Interview

With operational management team

Here the researcher will have an interview with the current project management team. The aim is to get an insight about the frequent users, reported complaints, hindering problems, demand and extent and project timely maintenance issues.

Interview questions

1. Who is the manager of the infrastructure unit?
2. What is your role in the project?
3. Do you think that the IIU is necessary?
4. What difference does it made from the previous trend of shower taking and laundry?
5. Overall No of users of the infrastructure reported
 - a. Per hour
 - b. Per day
 - c. Per week
 - d. Per age
 - e. Per gender
 - f. Per religion

Follow-up questions

Who are the frequent users of the project?

Per age...why do young and elderly peoples didn't use it?

Per sex ...why is the reason that females usage is insignificant?

Per religion ... who are the most users of the IIU?

1. What are the busiest days on the usage of the infrastructure unit per week?
2. What are the frequently reported complaints by the users?

Follow-up questions

Are there any technical complaints reported?

Are there any spatial complaints reported?

Are there any functional complaints reported?

Are there any aesthetical complaints reported?

Are there any geographical complaints reported?

3. What problems do you encounter while managing this infrastructure unit?

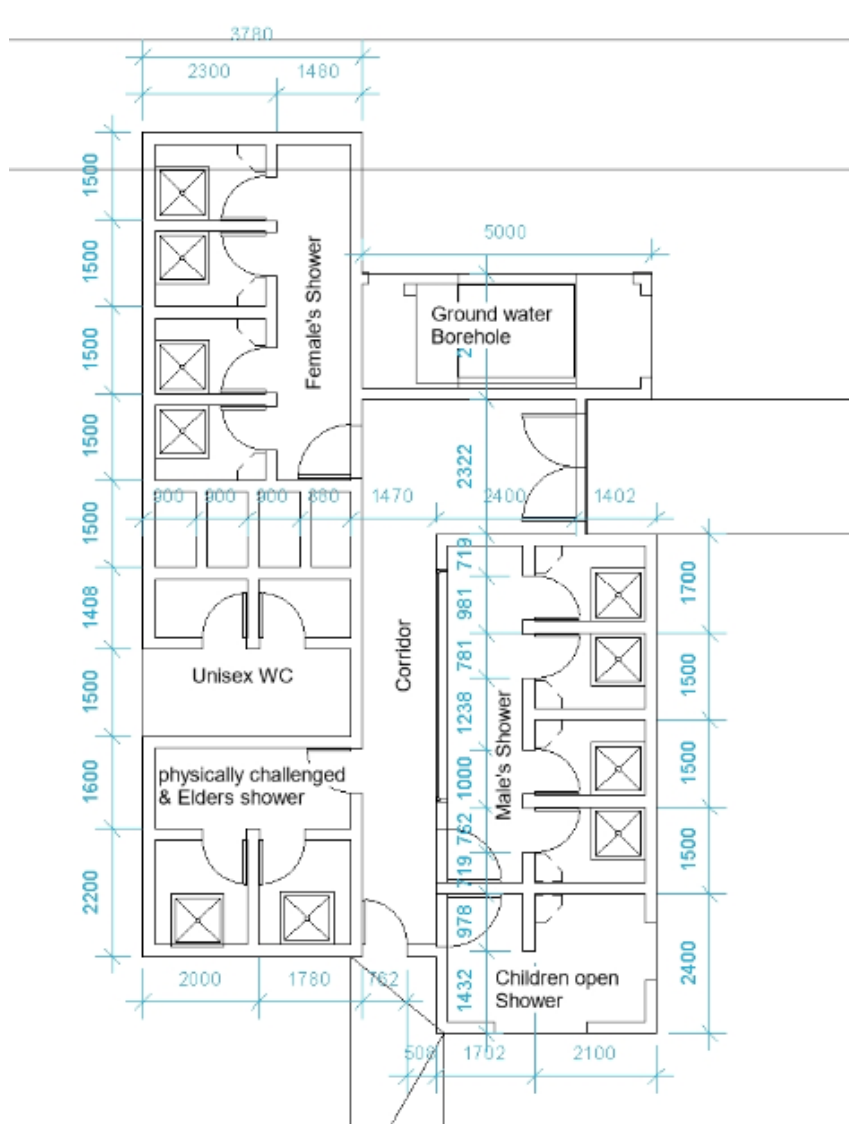
Follow-up questions

Are there any problems on water supply?

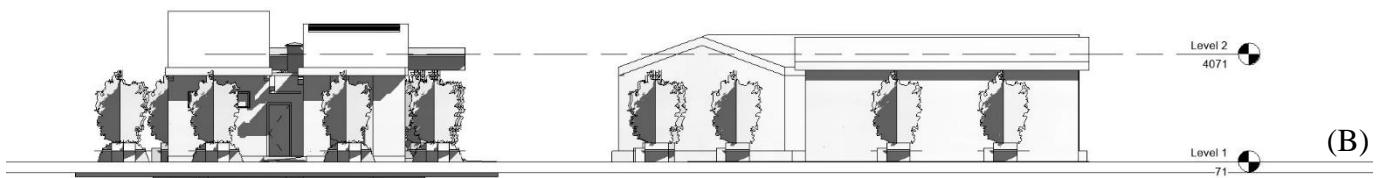
Are there any problems regarding waste management systems?

4. It seems it did not work out quite as the EiABC thought it would. Why didn't it work so well?
5. What would you say has hold the project back? What has hindered it from growing?
6. Have you maintained it?
7. What things do you maintain in the PSU?
8. How often do you maintain it?
9. What are your comments for the improvement of the PSU?

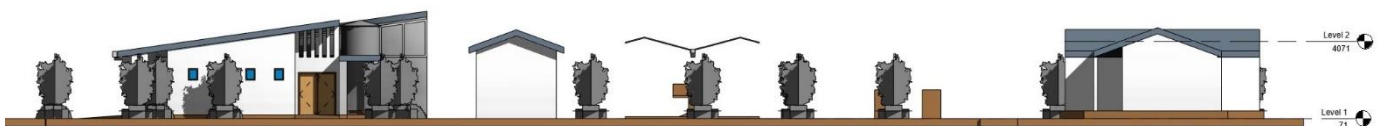
Appendix 4: Sanitation unit Proposal plan and elevations



(A)

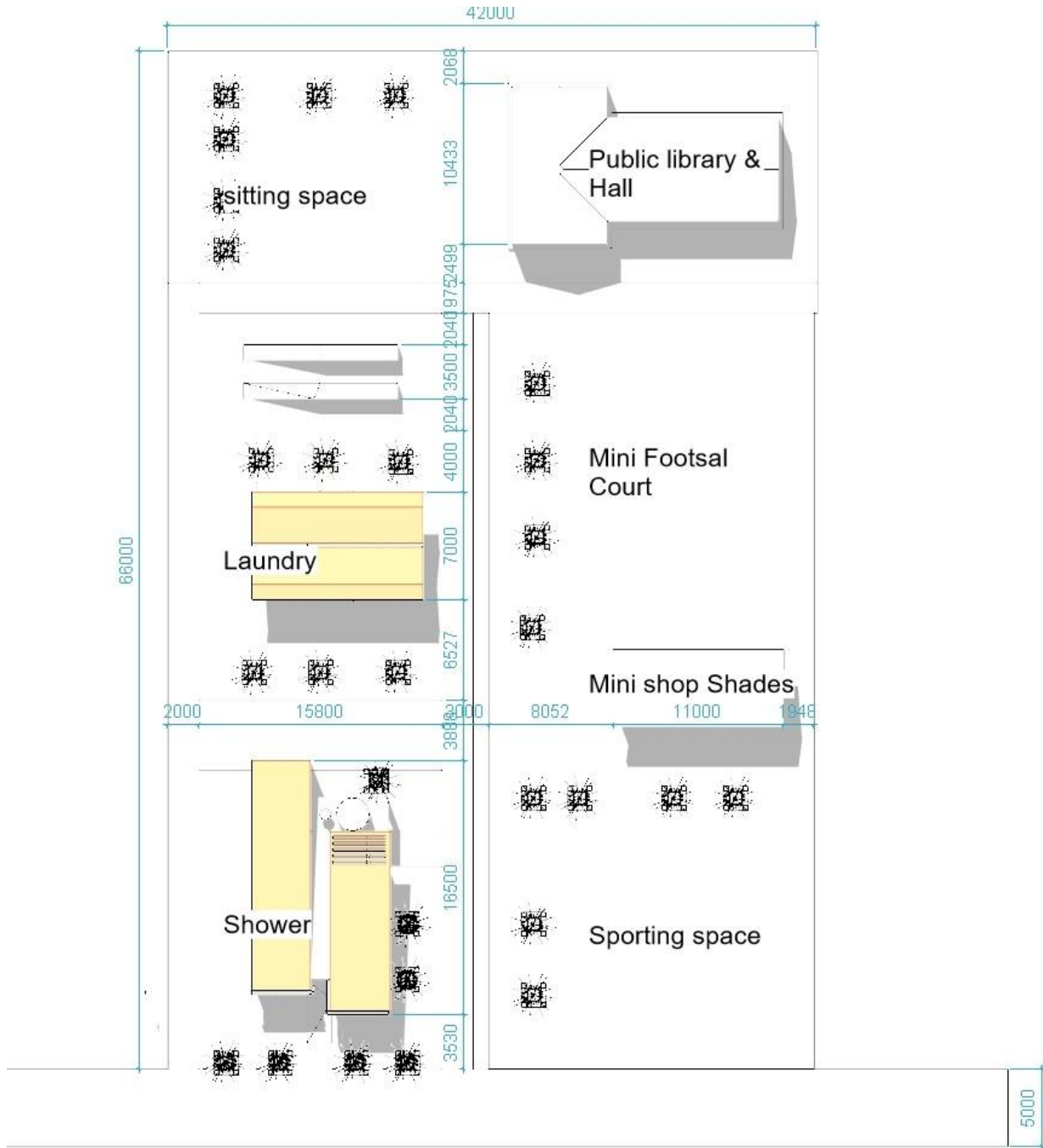


(B)



(C)

A-Shower unit plan (Sc. 1:200), B-Right side elevation, C-Front elevation (Sc. 1:500)



Proposed Public Sanitation Unit Site plan Sc. 1: 500

Appendix 5: Proposed Public Sanitation Unit 3D perspective views

