

V SUMMARY AND CONCLUSION

Water – Even though it is naturally renewed, fresh water was a finite resource. Availability of potable water had always been and will continue to be essential to human existence and economic growth. Throughout the 20th century, exponential population growth, greater urbanisation, and fast economic development were the three most influential factors in the creation and expansion of fresh water supplies. The cost of providing water supplies had steadily increased over the years, and this trend was expected to continue, as nearby sources were depleted, and it becomes necessary to extract it from great depths. Neighbouring nations or states that might result in potential conflicts and unpredictability over the availability of supplies.

Quantity and *quality* of the drinking water supply were top issues for human health. Water conservation was a crucial part of assuring the sustainable growth of a family, a city, and the environment. Any water conservation activity, such as the conception of water-saving technologies, was said to promote water conservation by increased water-use efficiency, decreased water waste and the development of water-saving devices. As water was a diminishing survival resource, the adoption of smart, unique, and inventive approaches for utilisation and conservation of the resources, particularly at the household level, was highly suggested in order to further simplify water management procedures. Efficiency in water consumption in the residential sector had a significant potential to lower the water demand in a city, and was connected with a wide variety of positive outcomes and benefits.

People today were more and more concerned about the quality of the water they drink. The most prevalent criteria they used to examine and appraise the goodness of water convey the health of ecosystems, the degree to which humans may safely interact with the water, the level of pollution in the water, and the quality of drinking water. The quality of water had a considerable influence on the availability of water and, often, it also defined the available supply alternatives. In light of this, the research project entitled *"Exploration of Domestic Water Management Practices and Paradigm Shift using IoT Enabled AI System for Devising Water Conservation in Ingenious Homes"* was initiated with the following objectives:

Objectives:

1. Recognize the socio-demographic profile of respondents as well as their degree of awareness, knowledge, attitude and lifestyle regarding domestic water consumption,
2. Identify the alternate water sources available, water conservation techniques used, water distribution, customs of storage and water consumption pattern among selected homemakers of Coimbatore city,
3. Evaluate the quality of water – physical, chemical and biological qualities - that has been stored for drinking purpose among the selected water samples,
4. Investigate individual water consumption analysis (micro-components), comparison using varied methodologies for different domestic activities in chosen houses,
5. Plan, implement and evaluate the impact of an intervention programme on the water-use behavioural attitude of selected homemakers and
6. Design a prototype model of IoT based effective water usage monitoring and control system using Transmission Control Protocol/ Internet Protocol (TCP/IP) that could be used for water conservation.

The study's hypotheses

The following research hypotheses were tested in this research. They were deduced based on the review of literature and the actual evidence.

H₀1. Selected socio-demographic variables does not influence the awareness on water conservation among the selected families.

H₀1.(a) *Selected socio-demographic variable - home maker's educational qualification did not influence the awareness on water conservation among the selected families.*

H₀1.(b) *Selected socio-demographic variable - family income did not influence the awareness on water conservation among the selected families.*

H₀1.(c) *Selected socio-demographic variable – type of house did not influence the awareness on water conservation among the selected families.*

H₀1.(d) *Selected socio-demographic variables – ownership status did not influence the awareness on water conservation among the selected families.*

H₀2. There was no association between the educational qualification of selected families and their usage of water conservation tools.

H₀3. Household's satisfaction about the quality and quantity of water distributed, irrespective of seasonal and non-seasonal variations, was not influenced by the distribution of water in their respective zones and the frequency of water supply.

H₀3.(a) *Household's satisfaction about the quality of water distributed during seasonal variations was not influenced by the distribution of water in their zone.*

H₀3.(b) *Household's satisfaction about the quality of water distributed during non-seasonal variations was not influenced by the distribution of water in their zone.*

H₀4. The properties (physical, chemical and biological) of water in different containers that has been stored during distribution cycle would not meet the quality standards set for its use.

H₀4.(a) *The physical properties (i.e) colour and turbidity of water in different containers that has been stored during distribution cycle would not meet the quality standards set for its use.*

H₀4.(b) *The physical properties (i.e.,) pH, electrical conductivity and total dissolved solids of water in different containers that has been stored during distribution cycle would not meet the quality standards set for its use.*

H₀4.(c): *The chemical properties such as iron and chloride content of water in different containers that has been stored during distribution cycle would not meet the quality standards set for its use.*

H₀4.(d): *The chemical properties such as hardness, alkalinity, calcium and sulphate content of water in different containers that has been stored during distribution cycle would not meet the quality standards set for its use.*

H₀4.(e) *The biological properties of water in different containers that has been stored during distribution cycle would not meet the quality standards set for its use.*

H_a5. The amount of water consumption differed for selected activities using traditional (manual) methods and labor saving devices.

H_a6. There was no significant difference between the quantity of water used for household chores by homemakers and paid assistants.

H₀7. The knowledge dissemination session did not result in any noticeable changes in water-conscious behaviour among the sampled homemakers.

Map of the Thesis

The map of the study involved four successive phases as:

Phase I : Descriptive Study: Homemakers' Socio-demographic Characteristics

Phase II: Experimental Investigation: Water's Qualitative and Quantitative

Status Quo

Phase III: Knowledge Germination and Dissemination and

Phase IV: Conceptualization of Design

The major aspiration of the research was to analyse current household water consumption behaviours among homemakers in the chosen city of Coimbatore and to develop a high-tech solution for residential water management administration.

It attempted to understand the attitudes of the chosen households from all the zones of Coimbatore city, with regard to domestic water management. The study was also conducted to assess the physical, chemical and biological parameters of water delivered in various zones of the Coimbatore district that was preserved for drinking purpose, water quality after common purification methods, quality of water stored in different containers and water consumption analysis by micro components. Furthermore, it included designing a mechanical prototype to monitor water use at all home's water outlets thus to improve water conservation and analysing the impact and comparison of behavioural attitude in pre and post sessions of knowledge dissemination programme on effective and efficient residential water management.

This research used a multi-methodological approach (also known as a multi-phase approach) accomplished in four phases. A *feasibility study* was taken up with 100 homemakers from the five zones of Coimbatore city. The Phase 1 was a descriptive study, basically a household survey comprised of 385 homemakers from all the five regions of the city – North Coimbatore, South Coimbatore, East Coimbatore, West Coimbatore and Central Coimbatore. The samples were chosen in stages or phases in multi-stage sampling. This Phase encompassed the socio-demographic background of the selected families, house details, water distribution system, from the point of supply to the free-flowing outlets of the distribution network, water consumption profile, water collection, and storage methods were deliberated in **Phase I**.

In **Phase II**, a concerted effort was made to assess the quality of the water collected from each of the city's five zones in relation to the drinking water standards established by the Bureau of Indian Standards and the World Health Organization (2012). It also discussed the physical, chemical, and biological properties of drinking water that has undergone various water treatments as well as water that has not been treated, as it was obvious that people subject to a variety of water treatments before consuming it.

It also included an investigation into the effect that various types of storage vessels, commonly used for water storage such as aluminium, brass, copper, mud, plastic, and steel, have on the water quality among the selected households located in the West zone of the selected city. Analysis were performed on the water's physical, chemical, and biological characteristics after it had been collected during the water delivery and after it had been stored in a variety of containers for a period of up to 20 days. The water used by the individual within the home (micro components) was obtained in this Phase to understand water consumption patterns and consumer behaviour.

In **Phase III** the knowledge dissemination session was imparted to sixty five homemakers from Ward Number 35 and 42 from the West zone of Coimbatore city in two sessions with the duration of three hours a day to improve the concern of water management through disseminating information and raising awareness. The effect of the information dissemination programme on selected homemakers'

knowledge, attitude, and practices of water management was measured before and after three months of the knowledge dissemination program.

In the Phase IV, an effort was made to design and create a mechanical prototype: *IoT Enabled AI System for Devising Water Conservation* where the concept of water consumption and conservation can be optimized as well as to meet the rising population's water demands and expectations.

The following were the most significant findings achieved during this research.

Phase I: Results of Descriptive Study: Homemakers' Socio-demographic Characteristics

Socio-economic Background of the Homemakers

- In terms of water supply, the selected households belonged to heterogeneous group. This was especially true in the selected city, where there was significant difference in the socio-economic background of the selected samples.
- About 30.6 per cent of homemakers belonged to the age group of 41 – 50 years. Among the surveyed homemakers 8.8 per cent of were still Illiterate, where 22 per cent had completed their Middle Schooling, 21 per cent were Graduates followed by 14 per cent Professionals.
- A greater proportion of 55.6 per cent were full-time homemakers and 71.7 per cent of the homemakers were from nuclear families with 35 per cent had 4 members in their families and
- A total of 28.1 per cent of the homemakers belonged to the category of middle income group earning about Rs. 20,001 – 30,000 per month. Out of the selected samples, 61.6 per cent were living in their own houses and 55.8 per cent of the homemakers were living in independent houses and 45.2 per cent of the were residing in that area for more than a decade.

Specifics of Alternate Water Sources Available

The Municipal Corporation supplied water to a majority of households. Tanker trucks and wells dug deep down helped to make up for the city's inadequate supply of Corporation supply of water. Every household that was considered for the study had a pipeline for soft water (drinking water) in their homes and the city Corporation was responsible for maintaining the water distribution system.

The sampled households used their on-site hard water connection for household tasks and through common street connections where water would be distributed at designated times. As an alternate households met their water needs from bore well; bottled water for consumption, water in tankers for non-drinking purposes, and rainwater was also used for drinking and other purposes when it was available.

Basics of Water Conservation Techniques

➤ Water literacy - Acquaintance of water conservation

- The Chi-Square value ($X^2 = 32.953$; $p = 0.002$) implied there was a highly significant association at 1 % level between the *educational qualification of the homemaker* and the *awareness of water conservation* among the selected homemakers.
- As the level of education increased, the awareness regarding water conservation also increased.
- The Chi-Square test result ($X^2 = 30.268$; $p = 0.000$) was judged to be statistically significant at the 1% level which showed that there was a significant relationship between *family income* and *awareness of water conservation*.
- Among the families whose family income was more than Rs. 40,000, 75.8 per cent were aware of the need of water conservation.
- It was found that the *ownership status of the homemakers* of the selected samples did not have any association with *awareness of water conservation* ($X^2 = 2.978$; $p = 0.561$).
- Awareness of water conservation was highly reported by 84.6 per cent of the homemakers who were residing in leased houses.
- With regard to the *type of house* of the homemakers, it was found to exhibit a significant association ($X^2 = 28.189$; $p = 0.000$) between the two variables.
- It was apparent that 93.9 per cent of the homemakers lived in triple portioned houses who had high knowledge of the concepts of water conservation.

➤ **Utilization of water conservation tools**

- Among the surveyed homemakers 41.8 per cent did not feel that the installation of water conservation technologies could be adopted to restrict the flow of water in any way.
- It was revealed that homemakers who earned more than Rs. 40,000 per month were more likely to employ water conservation tools. This percentage was highest among Doctors and Professors (57.1%). Chi-Square value ($X^2 = 36.865$; $p=0.000$) entails that there is a highly significant association between the *educational qualification* of the homemaker and the *usability of water conservation tools*.
- The relationship between the *family income* and *usage of water conservation tools* was tested statistically and found to be not significant ($X^2 = 9.442$; $p=0.050$).
- It is also evident that the *ownership status* of the selected samples did not have any relationship with the *usage of water conservation tools* ($X^2 = 5.265$; $p = 0.071$).
- The relationship between the *type of house* with *usage of water conservation tools* was tested statistically and the results ($X^2 = 1.087$; $p = 0.780$) revealed that there is no significant relationship between these two tested variables.

➤ **Understanding rainwater collection**

- The critical value ($X^2 = 15.758$; $p=0.027$) indicated a possibility of a significant association between the variables *educational qualification* of the homemaker and the *installation of rainwater harvesting* system at 5% level.
- The statistical analysis showed that ($X^2 = 5.192$; $p=0.268$) the *family income* of the selected samples did not had any relationship with the *installation of rainwater harvesting* system.
- The result that was derived ($X^2 = 9.362$; $p = 0.009$) implied that there was a highly significant association between the ownership *status* with understanding *rainwater harvesting* which was found to be significant at 1% level.

- With the critical value ($X^2 = 5.186$; $p = 0.158$) the output of the analysis proves that there is no association between the *type of house* and the presence of *rainwater harvesting* system.

➤ **Rainwater collection practices**

A total of 54.8 per cent of the surveyed homemakers did not save rainwater for a variety of reasons, including

- ❖ Could not spare time while raining (25%),
- ❖ No provision for collection of rainwater (14%),
- ❖ Space constraints for storing rainwater (12%),
- ❖ No particular reason (22%),

Effective use of rainwater was made by 45.2 per cent of homemakers. They collected rainwater for future usage in sump or containers.

➤ **Quantifying water waste**

- The investigated homemakers reported that most water was wasted in the toilets during flushing, followed by dishwashing (kitchen utensil cleaning) and overflowing water when filling the overhead tank. These three regions have been identified as hotspots for water waste.
- Concerning educational qualification, the Post Graduate homemakers had the highest mean water wastage score ($\bar{X} = 23.08$). With the higher mean knowledge score ($\bar{X}=22.70$) professional category homemakers who have the highest education stands second in water wastage.
- ANOVA analysis for Quantified Water Waste brings out that the residential water wastage was not influenced by the educational qualification of the homemakers ($F=.750$).

Information on the water distribution procedure

- Majority of the residents in the chosen city dreamt of having 24-hour water access from municipal taps.
- The city was prepared with massive pipe laying construction for a 24-hours water supply, which would be managed by the private provider 'Suez'. Municipal Corporation determined the frequency and hours of water delivery based on the availability of water.

- During the *non-seasonal period*, the homemakers (44.4%) got soft water once every 6 to 10 days. In 27 per cent of homes, water was delivered once in every 1 to 5 days, 11.7 per cent reported receiving water every 11 to 15 days; and finally, some do not know when water was supplied because the collection of drinking water was taken care of by the caretaker and they had RO systems in their houses for collecting water for drinking purposes.
- In *summer*, however, the frequency of water delivery varied significantly, with 16.9 per cent of assessed homes receiving water between 16 and 20 days apart and 7.3 per cent received water often more than 21 days once. They had to collect, store, and use water for 16 and 20 days until the next water delivery cycle.

Complete Contentment on the Availability of High-Quality and Sufficient Amounts of Soft Water

Quality and Quantity of Soft Water Supplied during Seasonal and Non-Seasonal Variation

i. Qualitative and quantitative satisfaction during seasonal periods

1. During *seasonal period*, more than half of the studied homemakers had a negative impression on the water quality supplied to them. Contradictory to this, few homemakers assumed the water supplied to them was of *good quality*.
2. When there was a high demand for water, particularly in the summer, 31.4 per cent and 26.2 per cent of homemakers reported feeling a significant level of dissatisfaction with the quantity of water that was provided to their homes.

ii. Qualitative and quantitative satisfaction during non-seasonal periods

1. A proportion (12.2%) of homemakers were Highly Satisfied and Satisfied (34%) with the *quality* of water during *non-seasonal period*.
2. A total of 14.8 per cent were Highly Satisfied and 55.6 per cent were Satisfied with the *quantity* of water delivered to them during months whenever supply exceeds demand (*non-seasonal period*).
3. Even though the demand for water was lower than the supply during non-seasonal times, 11.7 per cent of homemakers said that the amount of water they received was inadequate to meet their day-to-day needs.

Association between the attribute of satisfaction on the distributed soft water quality (during seasonal) of the selected homemakers with Zonal division in Coimbatore city.

- South zone homemakers were Moderately Satisfied or Not Satisfied with the water's quality and quantity, respectively. This zone also had the highest percentage of homemakers who were Not Satisfied.
- Homemakers in the West zone 42.9 per cent were Moderately Satisfied and 14.3 per cent were Not Satisfied with the water quality, respectively.
- In the East zone 48.1 per cent of Homemakers rated the supplied water quality as being Moderately Satisfactory. The water quality was acknowledged by 35.1 per cent of homemakers who were Satisfied and 5.5 per cent of homemakers who were Extremely Satisfied in all city Zones.
- About 46.8 per cent of homemakers in the North zone were Extremely Satisfied with the water quality.
- As indicated by the obtained critical value ($X^2 = 26.201$; $p = 0.010$), at a significance level of 1%, a highly significant association was found between the attribute of homemaker satisfaction with the quality of soft water distributed during the summer and Coimbatore zonal division.

Association between the attribute of satisfaction on the distributed soft water quality (during seasonal) of the selected homemakers with the frequency of water supply

- Fifty nine per cent of the homemakers recorded that they were Partially Satisfied (43.6%) and Not Satisfied (15.8%) with the frequency of water supply since it extends more than 11 days up to 25 days especially during summer months.
- The employed homemakers, and elderly family members were not aware of the supply of water.
- A high significant difference was recommended at the 1% level, and the results ($X^2 = 54,897$; $p = 0.000$) indicate that there was a strong correlation between homemakers' satisfaction with the quality of water, and the frequency of water supply particularly during summer.

Association between the attribute of satisfaction on the distributed soft water quantity (during seasonal) of the selected homemakers with Zonal division in Coimbatore city

- Homemakers in the city's central zone were Satisfied (44.2%) with the quantity of water supplied, while 26 per cent were not.
- Additionally, 46.8 per cent of homemakers in the South zone were Dissatisfied with the availability of water, while 32.5 per cent of homemakers in the West zone reported the same.
- There was a highly significant relationship between the satisfaction attribute and the quantity of soft water distributed (during the seasonal period) in various city zones.

Association between the attribute of satisfaction on the distributed soft water quantity (during seasonal) of the selected homemakers with the frequency of water supply

- Homemakers believed that two hours of water delivery with good pressure, once a week would be sufficient, as opposed to the current situation where the water flow is inadequate.
- With the frequency of water supply every 16 to 20 days and 11 to 15 days , 44.6 per cent and 30.5 per cent of homemakers were Dissatisfied with supply of water, respectively.
- They experienced both the fear of water scarcity and the crisis of water quality deterioration as a result of long-term water storage.
- A highly significant association at $p < 0.001$ level was found between the attribute of homemakers' satisfaction on the distributed soft water quantity (during seasonal) with the frequency of water supply across the city ($X^2 = 63.821$; $p = 0.000$).

Association between the attribute of satisfaction on the distributed soft water quality (during non-seasonal) of the selected homemakers with the Zonal division in Coimbatore city

- About 20.8, 41.6 per cent North zone homemakers and 16.9, 49.4 per cent of East zone homemakers were Highly Satisfied, Satisfied with the quality of water supplied during the non-seasonal period, respectively.

- High record of Moderately Satisfied and Not Satisfied were found among the homemakers from the South, West and Central zones of the city.
- The p-value ($p < 0.001$) at 1% significant level strongly suggests that there was a highly significant association between the attribute of satisfaction on the distributed soft water quality (during non-seasonal) of the selected homemakers with the zonal division in the selected city.

Association between the attribute of satisfaction on the distributed soft water quality (during non-seasonal) of the selected homemakers with the frequency of water supply

- Homemakers who received water supply once in 16 – 20 days (73.3%), daily (66.7%), and once in more than 21 days (60.8%) were Highly Dissatisfied with the quality of water.
- There was a strong relationship between the attribute of satisfaction on the distributed soft water quality (during non-seasonal) of the selected homemakers and with the frequency of water supply across the selected city.

Association between the attribute of satisfaction on the distributed soft water quantity (during non-seasonal) of the selected homemakers with the Zonal division in Coimbatore city.

- More than half of the homemakers were contented with the availability of supplied water in all the zones of the city except the South during the non-seasonal period other than summer.
- With a high significant level ($X^2 = 48.552$; $p = 0.004$), the relationship between the attribute of satisfaction on the distributed soft water quantity (during non-seasonal) of the selected homemakers with the zonal division in Coimbatore city was established.

Association between the attribute of satisfaction on the distributed soft water quantity (during non-seasonal) of the selected homemakers with the frequency of water supply

- The fact revealed that even during the non-seasonal period, a remarkable number of homemakers received water once in more than 10 days and also more than 16 days.

- This showed the unplanned circulation pattern in the water supply where the homemakers were put into a condition to store the available water irrespective of seasonal or non-seasonal periods.
- The satisfaction level seemed to be high among those who acquired water within 10 days duration.
- The critical value ($X^2 = 79.731$; $p = 0.000$) showed a highly significant association between the attribute of satisfaction on the distributed soft water quantity (during non-seasonal) of the selected homemakers with the frequency of water supply across the city.

Overall Satisfaction Regarding the Distribution of Soft Water

- A significant relationship between the educational level of homemakers and their overall happiness with the distribution of soft water at 1% level, [$F(7,377)=3.032$; $p=0.004$] was recognized.
- The level of satisfaction was greater among homemakers who had completed Middle School, and it also seemed to be higher among homemakers with advanced Degrees.
- The t-test revealed a significant difference between family income and overall satisfaction with soft water distribution at 5% level.
- Homemakers who were having a family income of less than Rs. 20,000 had a more positive outlook on the distribution of soft water.
- Neither the homemakers' home ownership, nor their house type had not influenced their satisfaction with the distribution of soft water supply.
- There was a highly significant relationship between homemaker residence zone and overall satisfaction with water distribution in the selected city. The East zone homemakers were the Most Satisfied, followed by the North zone.
- It indicated that a high degree of significance at 1% level was established between the frequency of water supply throughout the seasonal period (summer) and the overall satisfaction gained by homemakers.
- The overall satisfaction score was better for homemakers who received water distributions every 1 to 5 days and every 6 to 10 days.

Reasoning behind the Status of Inadequacy and Discontentment of Water

- Regarding the primary cause of water shortages, 45 per cent of homemakers cite seasonal variations (summer season), followed by frequent house guest visits (22%).
- Surprisingly, 22 per cent of homemakers reported that they had never encountered such a deficiency condition.
- Homemakers also mentioned regular cleaning activities in residences, an increase in the frequency of water supply, a larger family size, owner restrictions, negligence in fetching water, and a lack of prior notification about water supply as additional causes of inadequate water supply.

Phase II: Experimental Investigation: Water's Qualitative and Quantitative Status Quo

The salient findings were organised as follows:

Evaluation of the physical, chemical and biological qualities of water delivered in various zones of the Coimbatore district that was preserved for drinking purposes.

- Water samples taken from both the East and the West zones exhibited a little change in colour and lacked transparency. Hence, homemakers opted to pick any purifying process for drinking water.
- The overall result of the pH value implied that all the water samples included for this study from the five zones of the city were within the intended and appropriate range.
- The study's water was not considerably ionised and had a lower ionic concentration activity due to the lower dissolved solids.
- TDS concentrations in the current research were found to be between 88 to 254 mg/l, which was within Indian Standard Specification for Drinking Water and WHO limits.
- More precisely, in 60 per cent of the selected samples (south, east and west), **total suspended solids** ranged from 6 to 28 mg/l, while the north and central zones were devoid of suspended solids which was found to be within the standards.

- The experimental measurement indicated that there are no traces of carbonate in the samples collected.
- According to Indian Standard Specification for Drinking Water and WHO (2012) guidelines, the **chloride** content should not exceed 250 mg/l. In the five zones of the chosen city, the chloride concentration ranged from 19.5 to 24.82 mg/l in the study locations.
- Other chemicals found below the permitted level were water hardness, alkalinity, bicarbonate, iron, calcium, chloride, copper, fluoride, magnesium, manganese, nitrate, sulphate, sulphide, ammoniacal nitrogen, sulphide, ammoniacal nitrogen and silica.
- All the tested water samples showed no signs of microbial contamination (E.Coli, Coliforms).
- Water samples from the west zone had a total plate count of 65 CFU/mg, while those from the south zone had a total of 130 CFU/mg, suggesting a possible threat to water quality owing to the seeping of sewage pollutants into the pipes that provide the water.

Inspection of Drinking Water Quality after Common Purification Methods

- All of the collected samples were discovered to be clear and colourless.
- The odour of water samples gathered for this study was found to be consistent and pleasant.
- The pH of the water after various treatments ranged from 5.99 to 6.85.
- Turbidity ranged between 2.24 – 0.59 NTU which was less than acceptable limit.
- Leading packaged drinking water had high TDS value (420 mg/l), while low TDS was shown in RO water (168 mg/l).
- All of the samples taken were found to be free of suspended solids.
- The greatest hardness rating was discovered in packaged drinking water whereas in contrast, water that had not been purified by any of the procedures had a low hardness rating.

- The range of other parameters, which included bicarbonate, iron, calcium, chloride, copper, fluoride, magnesium, manganese, nitrate, sulphates, and silica, seems to be lower than the permissible level.
- All the selected samples were found to be free from E.coli and coliforms. Overall results indicated that the physical and chemical parameters were identified to be within the permissible limits set by Indian Standard Specification for Drinking Water and WHO (2012).

Monitoring and Assessing the Quality of Water Stored in Different Containers

i. Physical properties of stored water

The influence of various types of storage receptacles such as aluminium, brass, copper, mud, plastic, and steel on water quality which was commonly used for water storage among the selected homemakers from the West zone of the selected city was investigated.

- It was noticed that the colour of water on day 1 is 0.22, and the water stored in mud container showed reduction in colour where as the other containers ranged from 0.26 - 0.41 on the 5th day of water storage.
- The aluminium container exhibited pitting where a layer of scaling material was floating, causing the appearance to change.
- According to the overall results, all of the water samples were found to be clear and colorless, as well as within the limits specified by the Indian Standard Drinking Water Specification and the World Health Organization, even when preserved for more than 20 days.
- Hence the repeated measures ANOVA found that the difference in water colour across sample containers was not significant.
- Except for the water in the aluminium container, the total dissolved solids in all other sample containers increased significantly after 15 days of storage and
- With regard to TDS, based on the results it was advisable to consume water that was stored within 10 days, particularly in brass and copper vessels.

ii. Chemical properties of stored water

- There was a substantial variation in hardness between sample containers. It was also recognised that the hardness level does not vary during water storage.
- Water stored in plastic, brass and stainless steel containers showed a gradual rise in alkalinity. Notable raise could be seen in water stored in mud containers.
- ANOVA resulted that alkalinity of the water varied with different water storage containers as well as with the number of days the water was stored.
- Water stored in mud containers had a modest increase in iron concentration, but it was still within the allowed range set by the Indian Standard Drinking Water Specification and the World Health Organization.
- Except in mud containers, the mean average value of calcium was shown to decrease with the number of days the water was stored compared to the water evaluated prior to the procedure of water storage.
- Calcium levels in water vary with storage container. It did not change with the number of days the water was stored and
- It was identified that there was no significant difference in the materials of water storage container and sulphate content in the sampled water. The degree of sulphate present caused a significant variation in the frequency of water storage.

iii. Biological properties of stored water

- In accordance with the findings of this investigation, the quality of water held in brass and copper was superior to other containers like as aluminium, mud, and stainless steel.

Water consumption Analysis by Micro Components

- Household activities, like laundry, bathing, toilet flushing, and dishwashing were the most water demanding activities in the selected houses.

- The descriptive analysis findings revealed that 66.69 per cent of the available total water was utilized for activities such as laundry, bathing, and toilet flushing.
- Cooking and washing utensils consumed about 19.33% of the available water.
- Other fundamental tasks such as drinking and brushing utilised just 2.90 per cent of the water.
- The remaining water (10.94%) was used for outside home activities such as gardening, vehicle washing, and other reasons.
- Bathrooms and toilets were accounted for the greatest amount of water that was used.
- The data suggested that a significant proportion of households used overhead showers, as evidenced by the higher levels of water consumption for bathing.
- Pipeline or shower leaks could lead to water waste.
- According to the findings of the research, a substantial amount of water was used in the process of washing clothes manually.
- The ANOVA results illustrated that there exists a significant difference at 5% level between the quantity of water usage using traditional techniques and labor-saving devices.
- The findings indicated that conventional method of hand washing required a greater amount of water when compared to semi-automatic and fully automatic washing machines and the difference was significant.
- Taking into account the amount of water used by western flush systems, traditional flushing dramatically reduced water usage in toilets.
- The amount of water used for cleaning manually, with a single flush, and with a dual flush was found to vary significantly.
- It was discovered that the manual technique used to flush toilets used the least amount of water, while the dual flush method used the most.

- This finding underlined the increased water usage that was associated with western flush systems since it was necessary to flush the toilet not once, but twice or even three times in order to remove the solid waste.
- Fully automated washing machines used minimum amount of water in comparison to semi-automatic washing machines and manual washing and
- There was no significant difference at 5% significance level between the homemakers and paid servants with the amount of water consumed for washing clothes and utensils thereby, signifying that water consumption for household chores did not vary between homemakers and paid servants.

Phase III: Knowledge Germination and Dissemination

The findings that were uncovered during this part of the research are as follows::

Effectiveness of the knowledge dissemination programme on residential water management

- The degree of water conservation awareness and behavioural attitude towards water management among the designated homemakers was evaluated not only prior to the execution of the programme, but also three months after its implementation.
- Before the knowledge dissemination programme, 1.5 per cent of the total number of 65 homemakers were vehemently opposed to the notion that water was being squandered.
- Similarly, 44.6 per cent of respondents confessed to squandering water; however, after participating in the programme, only 1.5 per cent of respondents believed they were wasting water for household chores.
- In response to the knowledge dissemination effort, 47.7 per cent of the homemakers agreed and 32.3 per cent strongly agreed (5 points) that they were concerned with conserving water through minimising water waste and
- Presence of water leakages in the plumbing fixtures at home had reduced and moreover attending immediately to any reported water leakages as the major water conserving behaviours acknowledged by the homemakers at the conclusion of the knowledge dissemination programme.

Comparison of behavioural attitude scores before and after knowledge dissemination programme

- The average score for behaviour before knowledge dissemination programme was 36.86, with a standard deviation of 3.83.
- After the intervention, the average score increased to 42.40, and the standard deviation was 3.21.
- This point to the fact, that there was a shift for the betterment in the homemakers' behaviours related to water conservation.
- It was concluded that there was a positive behaviour change among the homemakers who participated in the knowledge dissemination programme on the subject "Community Vision on Water Management Practices".
- It was obvious, that there has been a favourable shift in behaviour among the homemakers.
- This showed that the participated homemakers obtained better awareness on water conservation behaviour and attitude after attending the knowledge dissemination programme.
- The level of awareness gained by the homemakers was significantly higher
- There was a statistical significant difference in the behaviour scores before and after knowledge dissemination programme, as indicated by the derived t-test value of 14.368, which was found to be significant at a level of 1%.

Phase IV: Designing the IoT Enabled AI System for Devising Water Conservation

- After conducted this research and reaching to the conclusion that water conservation need to be served as the major focus of efforts to relieve water scarcity, the researcher built a technology on "IoT Enabled AI system for devising water conservation." This decision was putforth after the findings of the research were analysed.
- *Therefore, the "Jalaflux Espy" mechanical prototype assembly was developed to monitor daily water consumption in each water outlet using LCD and mobile applications, where the data could also be compared to the previous day's water consumption.*

- The prototype was developed to monitor and evaluate the amount of water used in both the kitchen and the toilet.
- It was possible that by using the same technology, it would be possible to monitor the use of water at each and every water outlet in a home.
- Using a web browser, it was possible to keep an eye on the water distribution network and water flow throughout the entire property from any location.
- The user could set a daily water use restriction, and if that limit was surpassed, an alarm would buzz to indicate a water loss and notify the appropriate personnel to repair the faucets.
- Additionally, the mobile application had other feature that allowed the individual to determine the amount of water being used at any given time and also enabled us to set a daily water usage limit.
- The user may choose a daily water usage limit, and when the limit was reached, the alarm would be triggered.
- If continuous water discharge was required, the kill switch must be pressed. Otherwise, undetected water discharge would be signified by sending wastage notification alarm through mobile message and LCD to indicate water leakage and alert the relevant personnel to get the taps fixed.
- Despite the fact that there are innovations in IoT-enabled water management systems, this innovation had influenced artificial intelligence's decision to close off the water supply, thereby averting water loss.
- After being published for PATENCY by the Department of Commerce and Industry, this invention was elevated to its apex.
- The pageant produced for the programme was submitted for authorship (copyright) and certified by the Registrar of Copyrights in accordance with Indian Law.

Conclusion

To summarize, this research added new insights and expanded understanding on domestic water management know-how in Coimbatore. The present analysis found that poor water management remained a key issue. After this study, the IoT-enabled AI system for water conservation "Jalaflux Espy" was best-suited effort to address water insecurity. This smart water resource management system, "Jalaflux Espy", helped resolve the water issue. This would greatly reduce water use, manages usage, and detects leaks. Since it could also provided data on water flow, total water consumption, and analysis through a sensor interface, this invention could be a starting point for future researchers who wanted to find a better way to conserve water.

To protect water, water conservation habits has to be built up among different users through mass awareness programme. This study had shown the importance of teaching and inspiring homemakers about appropriate water management practices. So they embrace and advance highly prosperous modern technologies and aspire to meet 'fresh water for everyone' in the near future.

Water demand will persist. In fact, they will exacerbate if people, as a global community, do not internalize, respond, and use water responsibly. Therefore, let everyone, as people, families, communities, corporations and institutions, commit to utilize water in an efficient manner before it was too late to do so. The true sign of intelligence was not lavishness but rather conservation, which ensured that future generations would have the opportunity to continue to take pleasure in the blissful impression and soothing quality of water.

It was concluded with a final saying that

'Water crisis is ours to revolutionize, since we have the ability to transform the present water situation.'

Recommendations for Policy Makers

1. The potential of rainwater harvesting to increase water supply could be firmly acknowledged by each citizen, made obligatory by the governing body, and evaluated by the local authorities for its utility at all household level for its usefulness.

2. Apply appropriate water pricing by implementing a citywide metered system of revenue collection for water ingress and egress, ensuring that people pay for what they consume.
3. Water delivery at brief intervals can be made possible to prevent the degradation of conserved water quality.
4. Introduce a continuous 24*7 supply of water where water storage was unnecessary. It would also be a way to improve the purity of potable water with respect to all parameters.
5. School-going children could be inculcated with water conservation practices at an early age.
6. Enthuse start-ups projects related to water resource management for the budding researchers for the up liftment of technological ideologies.
7. Corporation, water supply board, government officials, and policymakers must have an understanding of the requirement for new water policies in order to put into action the appropriate strategies for addressing the town's water-related concerns.
8. Manufacturers of water purifiers should never recommend RO water purification systems for water containing less than 500 mg/l of total dissolved solids.
9. As the techniques and processes that Indian traditional water management relied on both accountable and sustainable, they need to be invigorated and revitalized.
10. The majority of homes do not have water meters, and those who use it pay a relatively affordable flat fee. Penalties may be levied on those who waste water unnecessarily.
11. Periodically, the stakeholders (community representatives, officials, policymakers, NGOs, regulating and authorised supply agencies, and researchers) of a city's water management ought to gather to discuss the viability and challenges of the intended ongoing water policies and to find solutions and
12. In addition, technological innovations, updated policy frameworks, new strategic master plans and market-based solutions that increase water supply

and decrease demand would be necessary to meet the current challenges associated with ensuring a sustainable domestic water supply.

13. This research would inform the City's Corporation, government officials, and policymakers of the need to establish new water policies in order to execute the appropriate methods for managing the town's water-related concerns and ensure efficient water management.

Suggestions for Future Research

A few suggestions for further research are enlisted:

1. A comparative research of rural and urban homemakers' approaches to water management in the family may be investigated.
2. To evaluate the attitude, behavior, knowledge, and practise of water management, a cross-cultural study may be done.
3. A big sample analysis on domestic water from all around the nation may be analysed to compile more specific data on residential water management methods, composition, and the link between socio-demographic characteristics and water conservation routines.
4. Suitable and cost-effective water administration strategy could be devised to prevent the misuse of precious resources.
5. Future study could be done to determine the efficacy of a washing machine and dishwasher based on the water consumption when working with various programme settings.
6. Large-scale knowledge dissemination sessions may be conducted by non-governmental organisation, social workers, among others to improvise and to determine the influence of such programmes on the homemaker/ household's attitude, behavior, and knowledge regarding domestic water management.
7. To reconcile the water's characteristics, both qualitative and quantitative, the implementation of further studies in the field of artificial intelligence pertaining to smart water management techniques can be accelerated and
8. Advanced level of converting the mechanical prototype knowledge of an IoT-enabled AI system for devising water conservation into a usable product form for its experience in the real world.