International Journal of Trade and Commerce-IIARTC
July-December 2024, Volume 13, No. 2, pp. 273-296
ISSN-2277-5811 (Print), 2278-9065 (Online)

COSMOS (Germany) JIF: 5.135; ISRA JIF: 7.249; ISI JIF: 3.721

An Investigation Study on the Factors that Influence Water Treatment Industry and Challenges from Business Perspective

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Abstract

This investigation study intends to recognise the facts and opinions of the respondents from the water processing industry regarding exploring the factors that influence the sewage treatment plant and water treatment plant further to look at the impact of automation in the water industry from the business perspective. The sample size was determined to be around 120. The convenience sampling method has been implemented to conduct the study in the Tamil Nadu region. The standard structured questionnaire has been provided to the participant to collect the necessary information based on their experience and expertise. Simple percentage analysis, relative importance index, ranking methods, and regression ANOVA methods have been deployed for analysis and result interpretations. The influential factors in the water treatment plant (WTP) and sewage treatment plant (STP) have been identified and ranked based on relative importance index. The results revealed that adoption of an automation system will boost the business performance. The results indicated in this study are limited to the region of the study area; it may differ from time to time and from one area to another.
Key Words: *Water, Process, Plant, Industrial, Automation.*

PAPER/ARTICLE INFO
RECEIVED ON: 28/10/2024
ACCEPTED ON: 09/12/2024

Reference to this paper should be made as follows:

Balaraman, Nirmal Kumar (2024), "An Investigation Study on the Factors that Influence Water Treatment Industry and Challenges from Business Perspective", *Int. J. of Trade and Commerce-IIARTC*, Vol. 13, No. 2, pp. 273-296.

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DOI: 10.46333/ijtc/13/2/4

1. INTRODUCTION & BACKGROUND

The conflict between India's growing population and the planet's fixed freshwater supply, & also declining water tables, has put pressure on the country to use grey water as an alternate water source for rural development. Another research shows the best design for a grey water treatment plant at the laboratory size. This hybrid treatment process combines physical and natural processes including aeration, agitation, filtration, and primary settling with cascaded water flow. When it came to the ability to remove water pollutants including COD (83%), TDS (70%), TSS (83%), total hardness (50%), oil and grease (97%), anions (46%) and cat ions (49%), the plant's economic performance for treating grey water from bathrooms, basins, and laundry facilities was demonstrated. Therefore, the method could be a useful substitute for treating grey water in rural residential areas (Pangarkar, B. L., Parjane, S. B., & Sane, M. G., 2010). In order to determine the local public's willingness to pay for upgrades to the capacity and technology of a sewage treatment plant (STP) in Chandernagore municipality, which is situated on the banks of the Ganga River in India, another study used a stated preference environmental valuation technique, specifically the choice experiment method. The findings show that in order to guarantee that the STP's whole capacity is utilised for primary treatment and that the technology is improved to allow secondary treatment, the people of this municipality are prepared to spend a sizable sum in the form of higher monthly municipality taxes. Overall, the findings presented in the paper encourage more funding to enhance STPs' technology and capacity to lower water pollution and, consequently, the health and environmental hazards that are currently endangering the viability of the cultural, religious, and economic values that this holy river produces (Birol, E., & Das, S., 2010). In Ghana, failure is commonplace in the country's urban sanitation infrastructure: less than 10 of the country's about 70 mostly decentralised waste fluid and faucal sludge treatment facilities are functioning efficiently. In order to identify the reasons that allow the few successful facilities to outperform their unsuccessful counterparts, another study provides an overview of Ghana's associated sanitation issue. The study finds significant variations between successful and failed facilities' finance plans, incentive structures, and operation and maintenance (O&M) strategies - differences that are most likely not exclusive to Ghana. As said by the results, a set of guiding questions should be included in the current planning, funding, or general decision-making framework in order to steer clear of frequently seen pitfalls that not only impede the advancement of sanitation service delivery but also negatively impact the environment and public health (Murray, A., & Drechsel, P. A. Y., 2011).Water and topsoil are being negatively impacted by the many operations associated with municipal sewage water and its treatment. The effect of municipal sewage water on the physico-chemical and microbiological characteristics of the subsurface water around the sewage treatment plant, which is situated in the southern region of Mysore city, is covered in another study. To assess the effects of sewage discharge on the subterranean water quality parameters, samples of underground water were gathered and examined in the vicinity of the sewage treatment facility. physical-chemical, Turbidity, total hardness, total dissolved solids, chemical oxygen demand, electric conductivity, The findings of the analysis of the subterranean water samples' chlorides, sulphates, nitrates, trace metals, and bacterial characteristics are addressed by contrasting them with the drinking water's allowable limits established by BIS Bureau of Indian Standards (Shivaraju, H. P., 2011).Maintaining community health and a safe, clean environment depends on the effective management and treatment of industrial and municipal waste fluid. For waste fluid treatment plants the use of standard SCADA systems improves operations, maintenance, process development, and cost savings. The architecture, interface to the process hardware, functionality, and capabilities of a SCADA software application installed on a waste fluid treatment plant are all covered in another paper. This application aims to establish a comprehensive real-time applications management environment for a contemporary waste fluid operation (Humoreanu, B., & Nascu, I., 2012).

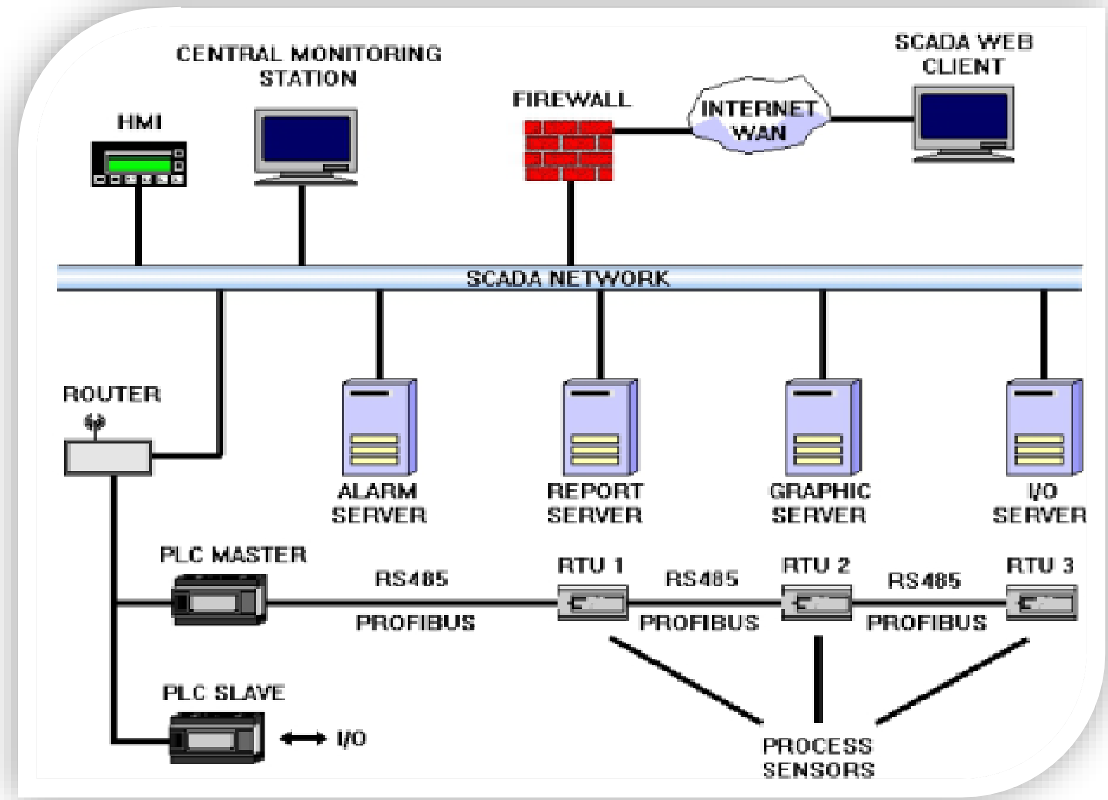


Figure 1: SCADA & PLC based water treatment plant
Source: (Humoreanu, B., & Nascu, I. et al., 2012)

The urbanisation movement in India is putting pressure on local government officials to supply infrastructure, safe drinking water, and sanitary facilities. Exploration of raw water sources and the development of treatment and distribution systems are necessary because to the fast population increase and the resulting portable water demand. The operational state of the water treatment facilities must be examined, and the most practical method must be investigated to guarantee appropriate drinking water production with the fewest rejections and its management.

In order to assess the drinking water purification process and identify any issues, a case study was carried out at the Bank Note Press Dewas MP, India facility. Conventional treatment often involves adding alum, coagulating, flocculating, sedimenting, filtering, and disinfecting with chlorination. Water treatment facilities are crucial to the process of purifying and providing people with clean water. The water treatment plant's comprehensive processing and administration at the BNP campus in Dewas, MP, India, meets the needs of the campus community. In order to meet the demands of people today and to compete with other facilities on a national and worldwide scale, the operation and maintenance must be updated (Mamta, B., Singh, B. S., & Monica, J., 2012).
Rapid economic development, rising urbanisation, and high population growth are putting strain on India's already limited water supplies. In order to alleviate some of the urban water concerns, waste fluid treatment and reuse might be crucial. Natural treatment systems (NTSs) are seen as a more affordable option that is more suited for the Indian setting because conventional treatment plants have several drawbacks. Another research highlights the potential and viability of NTSs in India by presenting a fast sustainability evaluation of 12 NTSs, building on a desktop analysis of NTSs. As said by the findings, NTSs offer a great deal of promise for treating waste fluid. Nonetheless, there are still unanswered questions about some elements that compromise the systems' sustainability. Operational issues, societal acceptance, and risks related to the reuse of treated waste fluid in agriculture were thought to be common obstacles. The usage of by-products and self-sustaining finance strategies were considered further advantages (Starkl, M., Amerasinghe, P., Essl, L., Jampani, M., Kumar, D., & Asolekar, S. R., 2013). Due to stricter regulations, the water sector is working hard to provide water of greater quality at a reduced cost. One industry that produces drinkable water is municipal water treatment plants. Following coagulation and sedimentation in the clarri- flocculator unit, they also generate a significant volume of sludge, a form of waste effluent that has a high concentration of organic pollutants and aluminium. It is frequently released into surface water without being properly treated, which pollutes the water. In totaling to being widely used for coagulation, aluminium salts have been linked to structural and functional issues in fish, birds, and mammals & also dialysis dementia, Parkinson's disease, and Alzheimer's disease in humans. Another study is on creating an environmentally sustainable, clean, and economical water treatment method to prevent water contamination from careless coagulant usage. The Shyamala Water Treatment Plant in Bhopal uses the Artificial Neural Network (ANN) technology to forecast the ideal coagulant dosage. The resulting alum sludge can be recycled and used again to cleanse waste fluid (Kriti, S., & Smita, J., 2013).

2. LITERATURE REVIEW

In order to mitigate fluoride and arsenic and offer safe and reasonably priced drinking water in low-income nations, a variety of technologies have been used in home devices or micro-water treatment facilities. Even though technologies have advanced significantly, businesses still struggle to make them profitable. The business strategies behind these water solutions are called into question by financial sustainability. In totaling to highlighting the rise of hybrid business models, the study describes four business models: low-value devices distributed to individuals in extreme poverty, high-value devices sold to low-income consumers, communities as recipients of micro-water treatment plants, and entrepreneurs as franchisees for the sale of water services. The research also demonstrates modern business model advances such distribution channels, secured and prolonged water payments, cost transparency and reductions, and business diversification. Thirdly, it defines competences and skills as a component of capacity building for further improvements in business models. A greater understanding of the role business models play in scaling up water treatment technology will result from these three contributions taken together (Gebauer, H., & Saul, C. J., 2014). Present-day industrial practices and the literature still lack rigorous approaches for carrying out eco-design of process facilities. It would seem bold to employ a fully integrated Process Modeling and Life Cycle Assessment (PM-LCA) technology in conjunction with suitable mathematical analytical techniques. Another study formalises a technological process for process eco-design to solve this problem. Using the suggested methodological approach, a drinking water treatment facility is examined. Based on a computational library of models for water treatment processes, the EVALEAU tool is a PM-LCA integrated simulator that includes a sensitivity analysis toolbox. A scenario for ground modeling that reflects the plant's normal operation is created and verified. A thorough examination of the plant model reveals the main environmental problems. Alternative modeling scenarios that are developed from the first one are used to evaluate a number of technical solutions. Then, intriguing technology solutions are integrated to create an ideal situation that succeeds to lessen the effects on the environment, such as reducing "Climate Change" by 17.2%. Simultaneously, operational expenses rise by 10.8%, exhibiting the opposite pattern. The suggested solutions show that the examined plant functioning is near optimal and are realistic when compared to field reality (Mery, Y., Tiruta-Barna, L., Baudin, I., Benetto, E., & Igos, E., 2014). For the activated sludge process in a waste fluid treatment facility, another research outlines a method to determine the most cost-effective controllable variables, even in the face of significant load perturbations. The closed loop control of these variables has been subjected to a novel dynamic analysis, taking into account a distributed NMPC-PI control structure and a nonlinear model predictive controller (NMPC), where the NMPC controls the self-optimizing variables and the PI controls the process active constraints. Applying the well-known self-optimizing control approach, the most crucial process measurements have been taken into account. With the least amount of financial loss, this technique offers the best set of metrics to maintain constant. Based on the nonlinear model of the process, a pre-selection of the measures has been made in order to prevent impractical dynamic operation. The capability of maintaining the measurements' values when usual disruptions are present has also been assessed (Francisco, M., Skogestad, S., & Vega, P., 2015).Using a case study of an industrial-scale drinking water treatment plant in Malaysia, common design and operational difficulties to assess the performance of an ultrafiltration (UF) membrane water treatment plant are emphasised. Since 2013, this treatment facility has been producing up to 14 million liters of drinking water per day for a small municipality utilising a dead-end polyether sulfone UF membrane filtering system. Solutions from the literature are contrasted with those that are used in practice, and the case study provides clarification. Disparities between industry practices and literature solutions, which are mostly grounded in laboratory-scale research, are noted. There will be significant effects on the design and functionality of industrial-scale UF treatment systems if this gap is closed (Chew, C. M., Aroua, M. K., Hussain, M. A., & Ismail, W. W., 2015). An excellent illustration of a developing nation whose water management handling has not been sufficiently modified to meet the demands of the new socioeconomic paradigm is the Republic of Serbia. Consequently, transportation wastes over 30% of the drinkable water produced, sewage collection and treatment fall well short of water supply, and only 10% of collected sewage is adequately treated, further degrading the already inadequate quality of water supplies. The objective of a study is to determine and assess the current obstacles that impede the creation and execution of an integrated national water resources management system in order to successfully manage the water resources for future generations and lessen the impending effects of climate change (Markovski, J. S., Hristovski, K. D., Rajaković-Ognjanović, V. N., & Marinković, A. D., 2015). China has seen a 57% rise in the amount of waste fluid processed; the large volumes of sewage have put both human health and the environment at risk. The rate of sewage handling has increased over the past ten years; as of 2013, 82.6% of Chinese counties and 99.1% of Chinese cities had sewage handling facilities. Another paper explains the current state of affairs and offers recommendations for resolving sewage issues in the future, particularly water pollution in China caused by the industrial, agricultural, and residential sectors. It also covers China's water quality regulations, handling facilities, and sewage systems for treating waste fluid from both urban and rural areas. Due to a lack of oversight and legal assistance, the research study emphasises the difficulties in effectively treating waste fluid in rural regions. This has resulted in inadequate sewage, handling facilities and standards, financial issues, inefficient management of handling plants, and a lack of knowledge. (Deng, Y., & Wheatley, A., 2016). Municipal waste fluid and industrial waste fluid are not the same. Reuse goals and treated effluent discharge limitations are usually the same and are based on the most advanced technology for treating municipal waste fluid. The primary unitary methods for handling are also the same, but appropriate adaption to distinct industrial waste fluid streams is required. Another study gives some examples of the difficulties caused by certain waste fluid sources, such as high total dissolved solids, high temperature, spent caustic, etc., and a lack of prior experience with similar methods, such as using membrane bioreactors for waste fluid from refineries, absorption chillers, plate and frame heat exchangers, or laws protecting sensitive environments that limit the amount of soluble metals or total nitrogen. It describes the strategies used to confront and overcome these obstacles in order to meet handling and/or re-use criteria. Aside from choosing between treated municipal & industrial effluents as sources for water reuse, general water cycle optimisation concerns surrounding industrial facilities with proper utilisation of existing waste fluid handling units are also covered (Zaffaroni, C., Daigger, G., Nicol, P., & Lee, T. W., 2016).The discovery of aerobic granules occurred about 20 years ago. Usually measuring between 0.5 and 3 mm in diameter, they are spherical aggregates of mixed microbial culture. For actual waste fluid handling, aerobic granule-based technology has been applied effectively on a large scale. The aerobic granule-based method is thought to have the potential to displace the conventional activated sludge process. One benefit is that aerobic granule-based waste fluid handling facilities may be constructed on around 25% of the area that traditional activated sludge-based facilities need. The operational cost may also be lowered by around 25% using this technique. Other benefits of this technique include a 30% reduction in energy use and a decrease in the creation of sludge. The production of granules happens somewhat slowly. Actually, a full-scale implementation of this technology is hampered by the granule formation time. Uncertainty surrounds the process behind aerobic granule production. Therefore, more research into the molecular process of granule formation would be essential to this technology's successful commercialisation (Sarma, S. J., & Tay, J. H., 2018).In many situations, small-scale waste fluid handling systems offer a practical and affordable substitute for big, centralised systems. Nevertheless, relatively few low- and middle-income nations were able to scale up such systems in spite of their enormous potential. Another research looks at the obstacles in Egypt's case and offers suggestions to governments and utilities on how to make it easier for them to do so. Institutions are the primary obstacle. Utilities must apply change-promoting factors, such as thinking at scale, achieving economies of scale in both management and implementation, modifying the effluent standards, and involving the business sector and civil society (Reymond, P., Wahaab, R. A., Moussa, M. S., & Lüthi, C., 2018). Despite being somewhat more costly than other solutions, about six municipalities have already used the imported modular waste fluid handling knowledge since there isn't enough room for far less expensive waste stabilisation ponds. Currently, more than 80% of urban dwellers in Bhutan rely on on-site sanitation systems to dispose of their household waste fluid; nonetheless, more than 40% of these homes lacked a soak-pit system for the secure disposal of septic tank effluent. (Dorji, U.et al., 2019). In order to encourage critical research and a fresh perspective on secondary disinfection throughout the scope of distribution systems, another study critically assesses the current paradigm of water distribution system management and compares it with the possible advantages of using UV irradiation. The goal is to spark a judicial re-evaluation of the current practices in water distribution system management. Researchers now see UV applications for disinfection in many areas of consumers' lives, including coffee makers, water coolers, dishwashers, and personal items like toothbrushes, gym bags, and water bottles. This is due to the recent advancements in UV technology and the effectiveness of UV disinfection against all pathogen classes. New strategies for disinfection and distribution system management are required due to public and regulatory concerns about water quality and pathogens, particularly the increased interest in building plumbing. Researchers are now working on a novel model for secondary disinfection in water distribution systems that makes use of the newly developed germicidal UV LED-based disinfection technology. All pathogens can be highly disinfected by UV irradiation in water handling, and the production of controlled disinfection by-products may be reduced or even eliminated. What is the reason for the lack of consideration of UV as a secondary disinfectant for distribution systems? Researchers explain the rationale behind the advantages and viability of implementing distributed UV handling in this account to help safeguard distribution networks and preserve the quality of water that humans may consume.(Linden, K. G., Hull, N., & Speight, V., 2019).

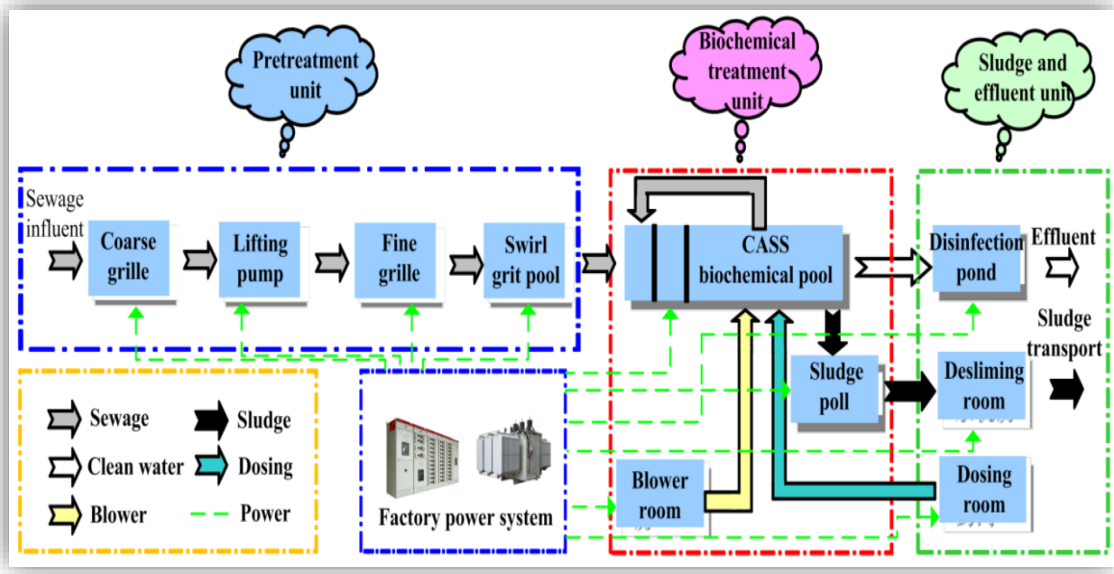


Figure 2: Sewage handling plant: Renovation of automation system based on Industrial Internet of Things Source: (Zhu, W., Wang, Z., & Zhang, Z. et al.., 2020)

Reducing industrial expenses and resources, & also increasing industrial efficiency and quality, are all made possible by the Industrial Internet of Things (IIoT). However, as of right now, there aren't many publicly available real-world IIoT project applications. It is particularly difficult to upgrade industrial automation using IIoT technology while requiring less capital for older automation equipment in conventional industries. An experiment introducing the automated upgrade of a sewage handling plant is based on real-world engineering expertise. Receiving water bodies can be shielded against water contamination by the physical, chemical, and biological handling methods used in conventional waste fluid (WW) handling plants. The waste fluid handling plant's (WWTP) construction and operation would be more difficult and demanding due to the common design limits, difficulties, and environmental effect. The WW plant design is subject to several significant project restrictions, including financial considerations, technical needs, institutional setup, environmental and health concerns, human capability, and political commitment. The project site, unit selections, design capacity, design duration, layout plan, and closeness to the population were all incorporated in the design technique used in the study. Details, safety concerns, environmental effects, design challenges, and effluent quality standards were briefly covered in another research. It also emphasised the necessity for adaptability for the successful completion the handling within the intended range of influent WW flows and properties. The paper also explains how each design stage was checked against environmental regulations and how to get around any restrictions when creating WWTPs so that the optimum handling performance could be achieved by using the standard operating code for the area. The optimal design parameters for field application were achieved by optimising the analytical calculation findings. In the field application, the optimised values also lower the costs of building and operation (Chowdhury, S. R., Alhelal, F., Alahmadi, M., Alqahtani, N., Alkhaldi, A., & Asiz, A., 2020). The rural water environment in China has gotten so bad that it is now threatening the rural areas' ability to thrive. The Chinese government has been encouraging waste fluid handling plants in rural regions as a solution to this problem. But after only a few years, some of these waste fluid handling facilities have closed. Therefore, even if the amount of recently constructed plants in rural regions has been rising quickly, the founding of an effective waste fluid handling system in rural China may be hampered by the failure of these plants. Another study uses the case study technique to examine the difficulties in managing the built waste fluid handling amenities in rural China. Two instances from the provinces of Zhejiang and Hainan were examined independently; the surgery in the former was successful, while in the latter it was unsuccessful. As said by the study, the WTS in rural areas faces a variety of implementation challenges, including unsustainable funding sources for process & upkeep costs, an unsuitable governance structure, possible hazards from the government's local leadership rotation system, low farmer participation in management, and technical complexity ((Liang, X., & Yue, X., 2021).It is crucial to create plans to cut water usage and increase the security of water supplies as the effects of water scarcity in the US worsen during the twenty-first century. Diversifying the sources from which water is obtained is one such approach. The bulk of the water used in the United States comes from fresh surface and groundwater, while industrial withdrawals make up the fourth biggest category. The possibility of using industrial effluent as a substitute water supply by means of direct handling and reuse is examined severely in another research. Reviewing the current state of water use, handling, and reuse in six representative industries-food and beverage, primary metals, pulp and paper, petroleum refining, chemicals, and data centres and campuses—the study starts by pointing out important obstacles and prospects for reuse growth. Additionally, it uses a techno-economic evaluation of water handling procedures to examine the capital expenditure, running and maintenance expenses, levelized water cost, and electricity usage of three particular industrial facilities as case studies in order to gain a better understanding of the areas in which research can foster significant innovation. The findings of the literature study and techno-economic assessments, which offer a comprehensive perspective on the future of industrial water reuse and address methods for its growth, are finally compiled (Meese, A. F., Kim, D. J., Wu, X., Le, L., Napier, C., Hernandez, M. T., & Kim, J. H., 2021). Because contaminants of emerging concern (CECs) have both acute and long-term impacts on living things, there is now growing concern about the contamination of aquaculture products and effluents by CECs resulting from direct chemical usage in aquaculture operations or nearby businesses. Antibiotics, antifoulants, and disinfectants are the most often found families of CECs, which have also been found in aquaculture water, sediment, and culture species. CECs have the ability to accumulate in aquaculture product tissue and eventually be ingested by humans. At the moment, CEC-containing effluents are released into the environment, causing sediments to eventually poison rivers as receiving bodies. Concerns about the contamination of water, sediment, and aquaculture products by CECs arise during the raising (grow-out) phases of aquaculture operations. All aqua-culturists should be subject to adequate rules that regulate the use of chemicals and guarantee adherence to standards for proper waste fluid handling. Several methods, including as adsorption, wetland development, photo-catalysis, filtering, sludge activation, and sedimentation, have been investigated for treating aquaculture effluents polluted with CECs. The discussion of the difficulties that CECs provide to aquaculture operations aims to gain understanding of present problems and offer potential solutions for related concerns in the future. The results given in the study are anticipated to be beneficial to stakeholders, including environmental and aquaculture researchers. The findings may also be helpful in determining the toxicity of CECs to live biota, reducing pollution, and developing rules pertaining to aquaculture (Ahmad, A., Kurniawan, S. B., Abdullah, S. R. S., Othman, A. R., & Hasan, H. A., 2022).The issue of supplying rural communities with potable water and directing the water delivery system is brought up in another research. A centralised water supply system should be installed. Given the current layout of rural settlement lands, crowded living quarters, and the abundance of structures, the network will be built up in trays. In the trays, there will be two pipes. One pipeline will be utilised to irrigate green areas, while the other will be used for domestic and drinking purposes. In totalling to presenting the handling facilities' layout, the report talks about the technical schemes of the current and planned handling facilities (Sargsyan, A. M., Ilyin, N. A., & Drondin, M. S., 2022). In order to bridge the gap between intellectual capital and sustainability performance, another research created and experimentally supported a framework that specifically proposes eco-product innovation and external learning. A new conceptual model was produced through the mediation of eco-product production and external education, as suggested by the theory of dynamic capacities and knowledge-based vision. Additionally, the study examined 122 Indonesian bottled drinking sectors using the Partial Least Square-Structural Equation Modelling (PLS-SEM technique), revealing their willingness to collaborate. More specifically, by examining the function of external learning as being more significant than eco-product innovation, the study dissected new arguments. From a practical perspective, intellectual capital facilitated the sharing of information and knowledge among suppliers, distributors, and rival businesses Therefore, their understanding might be fully assimilated and transformed, which may enhance corporate performance (Salangka, M., Kameo, D., & Harijono, H., 2024).

3. STUDY OBJECTIVES & RESEARCH METHODOLOGY

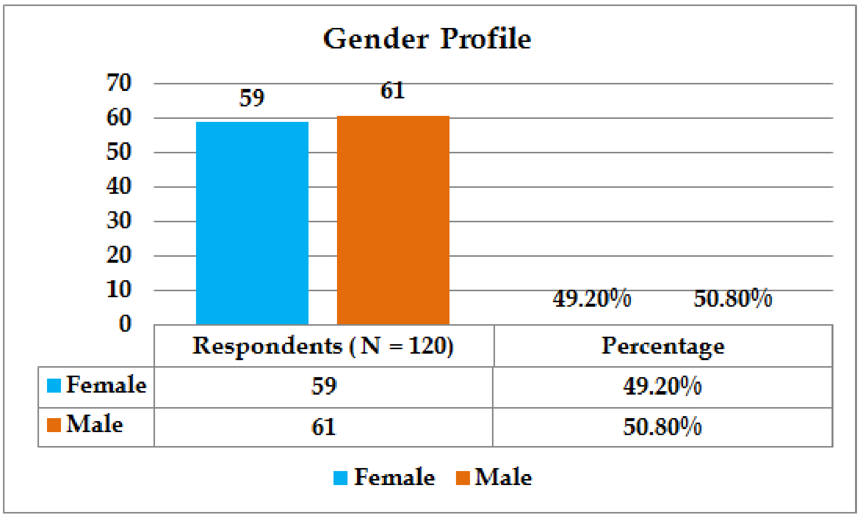
This investigation study intends to recognise the facts and opinions of the participant from the aquatic processing industry regarding exploring the factors that influence the sewage handling plant and water handling plant further to look at the impact of automation in the aquatic industry from the business perspective. The sampling magnitude was determined to be around 120. The convenience sampling method has been implemented to conduct the study in the Tamil Nadu region. The standard structured questionnaire has been provided to the participant to collect the necessary information based on their experience and expertise. Simple percentage analysis, relative importance index, ranking methods, and regression ANOVA methods have been deployed for analysis and result interpretations.

4. Results summary

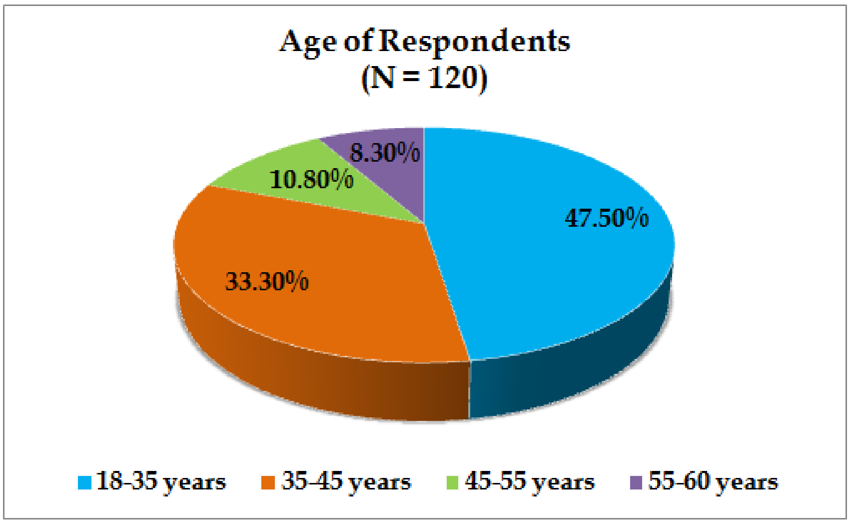
4.1 Factual Analysis

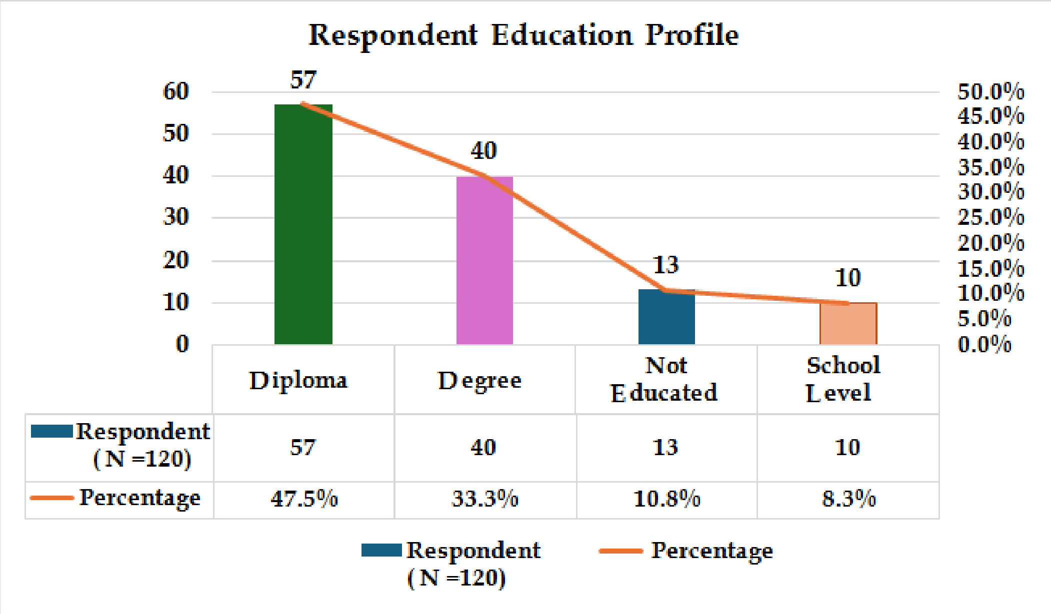
Table 1: Demographic Profile of Respondents

Gender Profile	**Respondents (N = 120)**	**Percentage**
Female	59	49.2%
Male	61	50.8%
Total	120	100.0%
Job Role		
Electrical maintenance engineer	19	15.8%
Instrumentation & Control Engineer	14	11.7%
Operations & Maintenance Manager	15	12.5%
SCADA / PLC Operators	22	18.3%
Design Engineers / Engineering manager	13	10.8%
Mechanical engineer / Civil engineer	18	15.0%
Construction manager	19	15.8%
Total	120	100.0%
Educational Profile		
Diploma	57	47.5%
Degree	40	33.3%
Not educated	13	10.8%
School level	10	8.3%
Total	120	100.0%
Age Group		
18-35 years	57	47.5%
35-45 years	40	33.3%
45-55 years	13	10.8%
55-60 years	10	8.3%
Total	120	100.0%



	Respondents (N = 120)	Percentage
Female	59	49.20%
Male	61	50.80%





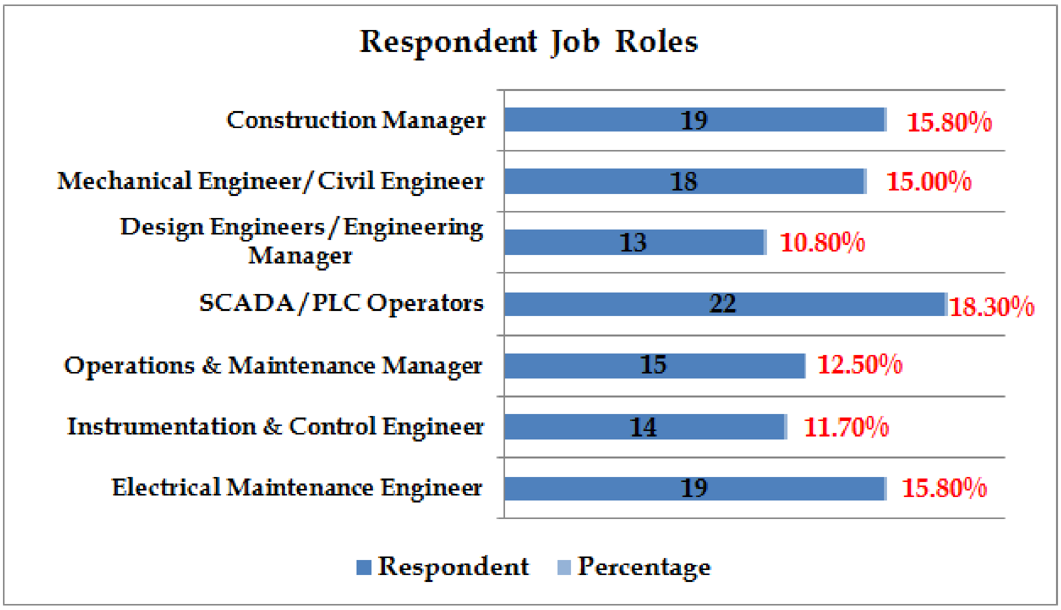


Figure 3: Facts and figures Demographic profile of respondents

Table 1 indicates the Demographic profile of respondents and figure 3 indicates its graphical representation. Further, Table 2 indicates Factors influencing Water Handling Plant and Table 3 presents the Water Handling Plant (WTP) factors impact Analysis data whereas Table 4 represents the Ranking of WTP factors based on relative importance index calculations. Table 5. Sewage Handling Plant (STP) factors impact analysis. Table 6. Ranking of STP factors based on relative importance index.

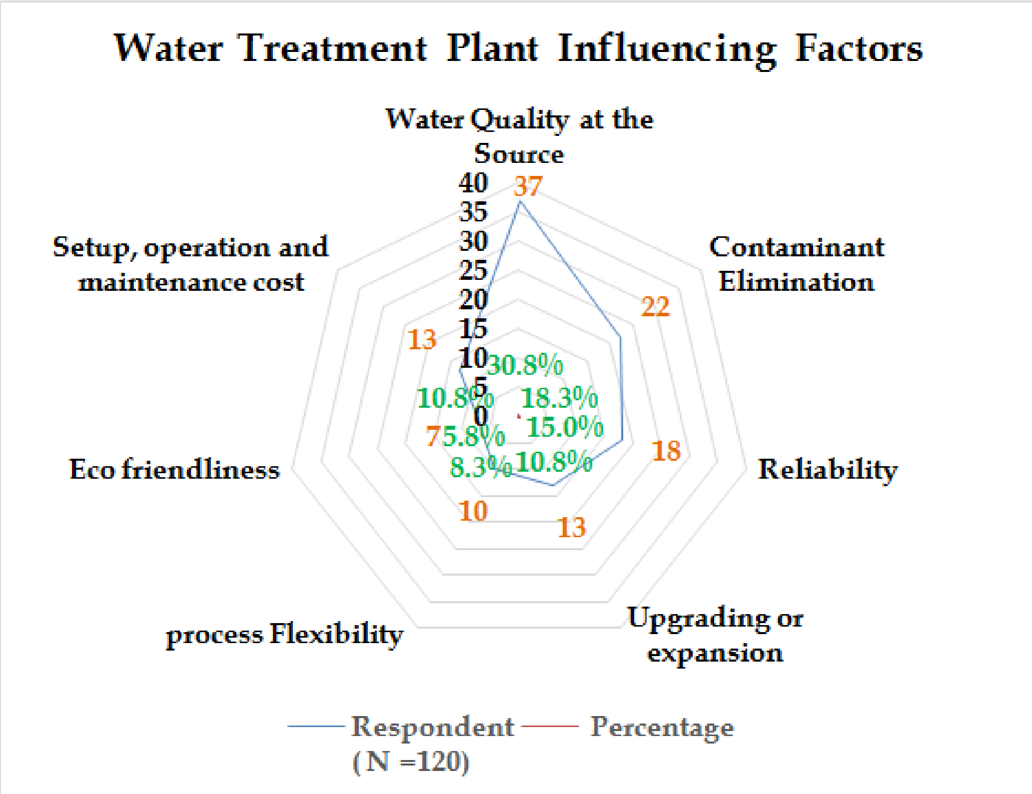


Figure 4: Water handling plant factor of concerns

Table 2: Factors Influencing Water Handling Plant

Water Handling Plant Influencing Factors	Respondents (N = 120)	Percentage
Water Quality at the Source	37	30.8%
Contaminant Elimination	22	18.3%
Reliability	18	15.0%
Upgrading or expansion	13	10.8%
Process Flexibility	10	8.3%
Eco-friendliness	7	5.8%
Setup, operation and maintenance cost	13	10.8%
Total	**120**	**100.0%**

Table 3: Water Handling Plant (WTP) Factors Impact Analysis

Water handling plant (Factors)	No Impact	Low	Medium	High	Very High	Total
Water Quality at the Source	36	12	24	42	6	120
Contaminant Elimination	31	31	21	33	4	120
Reliability	32	30	23	33	2	120
Upgrading or expansion	31	33	21	34	1	120
Setup, operation and maintenance cost	32	35	21	31	1	120
Process Flexibility	38	29	19	33	1	120
Eco-friendliness	61	21	35	3	0	120

Table 4: Ranking of WTP Factors Based on Relative Importance Index

Ranking of Factors Influencing the Water Handling Plant	Rank	W	RII = ΣW / (A*N)	Average	Mean	SD
Water Quality at the Source	1	330	0.55	2.75	2.35	1.34
Contaminant Elimination	6	308	0.51	2.57	2.24	1.23
Reliability	4	303	0.51	2.53	2.21	1.20
Upgrading or expansion	5	301	0.50	2.51	2.20	1.18
Setup, operation and maintenance cost	3	294	0.49	2.45	2.15	1.17
Process Flexibility	2	290	0.48	2.42	2.09	1.22
Eco-friendliness	7	220	0.37	1.83	1.61	0.94

Table 5: Sewage Handling Plant (STP) Factors Impact Analysis

Sewage Handling Plant (Factors)	No Impact	Low	Medium	High	Very High	Total
Monitoring and control systems	35	12	23	40	10	120
Equipment maintenance issues	35	11	24	42	8	120
Cleaning and Sanitization	35	13	24	42	6	120
Operator skills	31	27	23	33	6	120
Consistency of input / raw materials / chemicals / dosage	29	30	23	33	5	120
Existence of toxic substances	32	30	22	33	3	120
Plant Capacity issues	31	35	19	30	5	120
Clearance issues	36	29	18	33	4	120

Discharge regulations	32	34	21	30	3	120
Environmental factors	32	35	21	28	4	120
Engineering designs	37	29	19	31	4	120
Availability of resource issues	38	29	18	32	3	120

Table 6: Ranking of STP Factors Based on Relative Importance Index

Ranking of Factors Influencing the Sewage Handling Plant	Rank	W	RII = ΣW / (A*N)	Average	Mean	SD
Monitoring and control systems	1	338	0.5633	2.8167	2.4015	1.3841
Equipment maintenance issues	2	337	0.5617	2.8083	2.4007	1.3615
Cleaning and Sanitization	3	331	0.5517	2.7583	2.3643	1.3347
Operator skills	4	316	0.5267	2.6333	2.2893	1.2698
Consistency of input / raw materials / chemicals / dosage	5	315	0.5250	2.6250	2.2982	1.2371
Existence of toxic substances	6	305	0.5083	2.5417	2.2170	1.2223
Plant Capacity issues	7	303	0.5050	2.5250	2.2028	1.2364
Clearance issues	8	300	0.5000	2.5000	2.1537	1.2702
Discharge regulations	9	298	0.4967	2.4833	2.1716	1.2021
Environmental factors	10	297	0.4950	2.4750	2.1631	1.2089
Engineering designs	11	296	0.4933	2.4667	2.1239	1.2631
Availability of resource issues	12	293	0.4883	2.4417	2.1006	1.2555

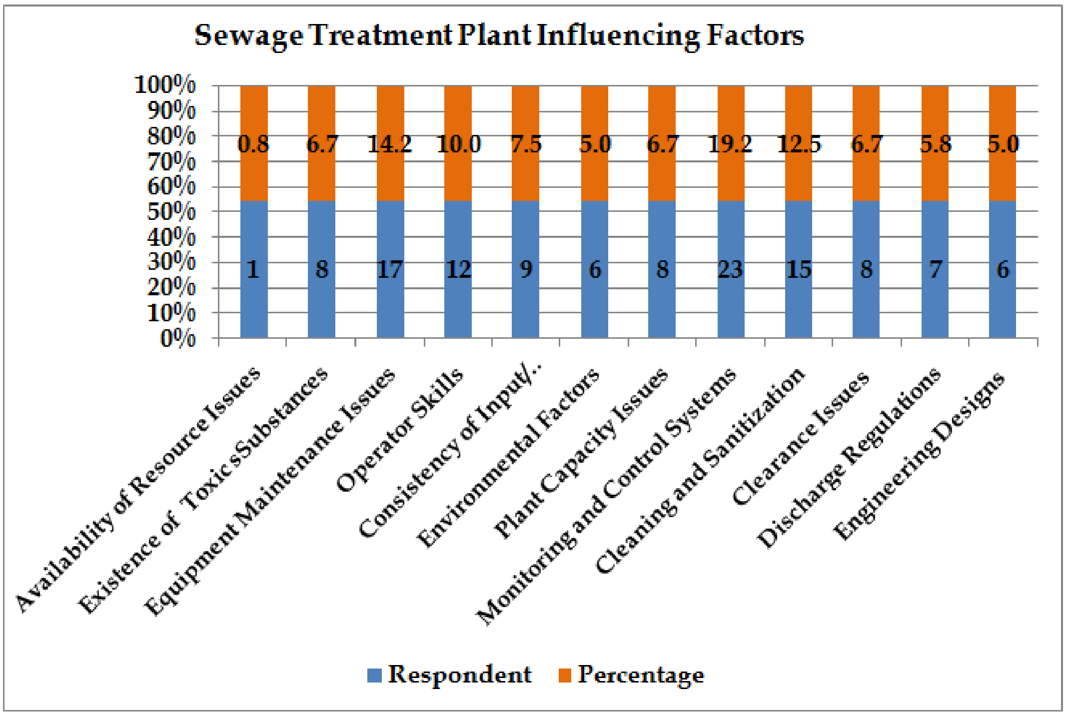


Figure 5: Sewage handling plant factor of concerns

Figure 4 indicates water handling plant factor of concerns whereas Figure 5 represents sewage handling plant factor of concerns.

4.2 Regression & ANOVA Analysis

Regression line equation $\hat{Y} = 1.0609 + 0.9916X$, Adaptation of Automation system DCS/ SCADA/ PLC system in water process industry predicted Impacts in Business performance, R2 = .99, F(1,118) = 14701.87, p < .001. β = .99, p < .001, α = 1.06, p < .001. Table 7 indicates the regression results.

Table 7: Regression ANOVA Results

Source	DF	Sum of Square	Mean Square	F Statistic (df_1, df_2)	P-Value
Regression (between $\hat{y}_i$ and $\bar{y}$)	1	724.5099	724.5099	14701.871 (1,118)	0.001
Residual (between y_i and $\hat{y}_i$)	118	5.8151	0.04928		
Total (between y_i and $\bar{y}$)	**119**	**730.325**	**6.1372**		

Impacts between Business performance and Adaptation of Automation system DCS / SCADA / PLC system in water process industry relationship R-Squared (R2) equals 0.992. This means that 99.2% of the variability of Impacts in Business performance is explained by Adaptation of Automation system DCS / SCADA / PLC system in water process industry. Correlation (R) equals 0.996. This means that there is a very robust straight connexion between Adaptation of Automation system DCS / SCADA / PLC system in water process industry and Impacts in Business performance. The Standard deviation of the residuals (Sres) equals 0.222.The slope: b_1=0.9916 CI[0.9754, 1.0078] means that incase an upsurge initiated in Adaptation of Automation system DCS / SCADA / PLC system in water process industry by 1, the worth of Impacts in Business performance increases by 0.9916. The y-intercept: b_0=1.0609 CI [0.9942, 1.1276] means that when Adaptation of Automation system DCS / SCADA / PLC system in water process industry equals 0, the prediction of Impacts in Business performance's value is 1.0609.The x-intercept equals -1.0698.Goodness of fit: Overall regression: right-tailed, F(1,118) = 14701.871, p-value = 0. Since p-value < α (0.05), hence reject H0 null hypothesis. The linear regression model, Y = b0+ b1X + ε, provides a better fit than the model without the independent variable resulting in Y = b0 + ε. The slope (b_1): two-tailed, T(118)=121.2513, p-value = 0. For one predictor it is the same as the p-value for the overall model. The y-intercept (b_0): two-tailed, T(118) = 31.4847, p-value = 0. Hence, b_0 is significantly different from zero.

5. Discussion

Another experiment shows how a contemporary DCS may be used in the energy sector for substations that transmit and distribute electricity. The benefits of investing in a modern automation system may be significant when dealing with ageing infrastructure. These benefits include improved integration with contemporary IT facilities, cost savings, safer operations, increased productivity, and scalable solutions. Modern DCS systems have developed into scalable and adaptable automation solutions, making them essential in the highly competitive energy industry. Modern DCS systems, in contrast to PLCs and conventional DCS, are made to offer automation solutions in a way that is safe, dependable, and economical. The research's primary objective is to present and recommend an ideal DCS design and functional solutions while taking into account the needs of the client, applicable international and customer standards, financial constraints, hardware and software limitations, integration of current equipment, cyber security, and the minimal impact of the monitored and controlled process for future expansion (Poștovei, D. A., Bulac, C., Triștiu, I., & Camachi, B., 2020).

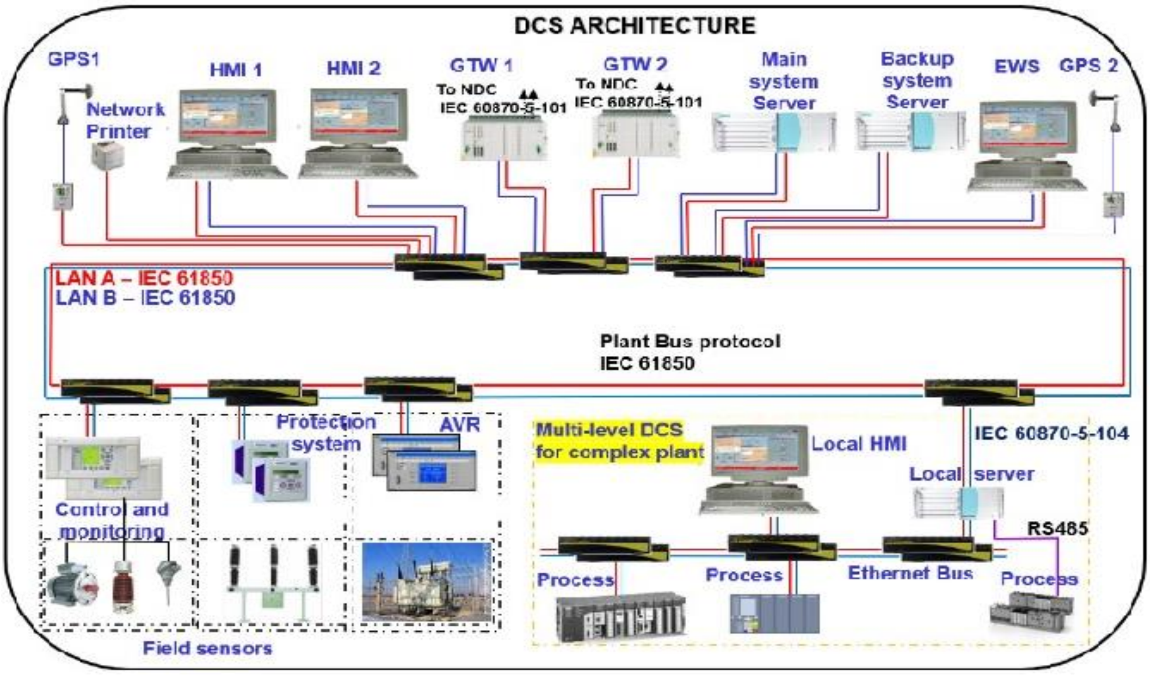


Figure 6: Distributed Control system architecture
Source: (Poștovei, D. A., Bulac, C., Triștiu, I., & Camachi, B. et al., 2020)

An urban area is defined as a place with a high population density and a high building density where people live systematically near to one another. People in these places often make their living in offices, factories, industries, and civic institutions. Urban activities include the movement of commodities by heavy and light diesel vehicles & also human activity, which contaminates the atmosphere and alters the chemistry of the earth, water, and air. Cities, towns, and other metropolitan regions have very different land use patterns than rural villages, where agriculture occupies the majority of the land. Urban water quality has declined consequently of many solid and liquid waste types produced by human activities such as residential, industrial, automotive, and construction, which might endanger the health of city people. The water may include a variety of contaminants, including biological and plastic materials, organic and inorganic substances, and heavy metals. Increased concentrations of harmful contaminants in water are mostly caused by the discharge of untreated industrial effluents. The health of city people may be significantly impacted by the use of untreated, polluted water for household uses. Therefore, preventing water pollution in urban areas may be greatly aided by the efficient and appropriate operation of sewage handling plants (STPs) established there. Although it might be difficult to manage both liquid and solid waste in urban settings while maintaining the natural water quality, pollution of urban groundwater and surface water can be prevented by implementing stringent and uniform solid waste management procedures. Likewise, sewage water and industrial effluents need to be treated before being released into the environment. The origins of urban water pollution, their effects on human health, and recommendations for clever strategies for their prevention and reduction in order to save human societies and other living things are the subjects of another research (Singh, N., Poonia, T., Siwal, S. S., Srivastav, A. L., Sharma, H. K., & Mittal, S. K.,2022). The danger posed by micro plastics (MPs) in aquatic environments is almost a brand-new environmental management issue. In totalling to collecting MPs from human activity, municipal waste fluid handling facilities (WWTPs) also release MPs into the environment. The purpose of another study is to ascertain the quantity, properties, and elimination of MPs in a municipal WWTP using a traditional activated sludge procedure. Over the course of a three-month sampling campaign, composite samples from waste fluid and sludge were collected in order to study the MP particle size/type, influent loads, and removal rate in the bar screen, grit chamber, primary sedimentation, returned activated sludge, and secondary clarifying units of this WWTP. After the grit chamber and pieces were common in the effluent, fibres dominated the shapes of the samples that were collected. In the majority of waste fluid samples, polyethylene polymer was found. Although MP particles may be effectively removed by current handling methods, they nevertheless pose a risk to the aquatic habitat (Asadi, A., Khodadost, F., Pirsaheb, M., & Davoodi, R., 2023).

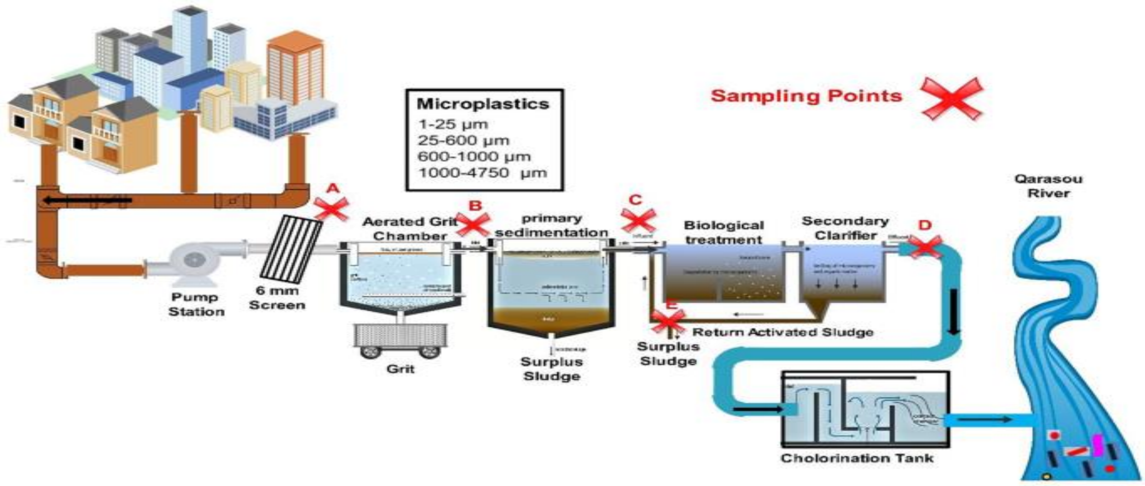


Figure 7 -removal of micro plastics during municipal waste fluid handling plant
Source : (Asadi, A., Khodadost, F., Pirsaheb, M., & Davoodi, R et al.,2023)

The world has experienced fast urbanisation and a sharp increase in population in recent decades. Consequently, there is now more demand for water, which raises waste fluid levels. Untreated waste fluid combined with water constraint has become a serious global challenge. The duty of cleaning waste fluid and satisfying needs from industry, agriculture, and households present challenges for municipalities. Waste fluid mishandling has negative effects on the economy, society, and environment. India is a country full of potential and innovation in the waste fluid management (WWM) industry because of its large population density, poor sanitation and water security, low awareness, and obvious pollution. A thorough overview of waste fluid management and business strategy is provided by another study. To identify, acknowledge, and interpret the key aspects for the stakeholders and prospective businesses looking to enter the waste fluid management industry, the study used Total Interpretive Structural Modelling (TISM). The report offers guidance on creating a circular economy solution and presents a clear framework that highlights the vital fundamentals of a profitable WWM company. Additionally, by giving priority to resource-efficient solutions, the research helps practitioners in the WWM business assess their alternatives and gives them guidance (Narang, D., Madaan, J., Chan, F. T., & Charan, P., 2024).Primary and secondary plastic pollution is an environmental problem that has prompted both international and regional regulatory initiatives. The effects of micro- and nano-plastics on ecosystems and human health are being studied more and more, and governments all over the world are working to solve this problem. In many nations, national rules or regulations have been implemented consequently of regulatory initiatives promoted by the international community. Primary, secondary, and nano-plastics are prohibited or their usage is restricted by these restrictions. The regulatory frameworks of Europe and the world are summarised in order to put the US in perspective. In an attempt to trace the evolution of plastics regulation in the United States, a description of regulatory agencies and their functions in promoting regulations and policies, & also future directions and opportunities for improvement in plastics regulation, are presented. A comparison of regulatory regimes is also included, as is a discussion of the implications of new rules on utilities and sectors (Estahbanati, S., Upadhyaya, G., Wells, M. J., & Bell, K. Y., 2024).

6. Conclusion

The highest volume of sewage that a sewage handling facility can handle in a given period of time is referred to as its capacity. The plant can efficiently remove all contaminants from the sewage if it is overwhelmed, producing treated water that ought to be cleaner. But doing so might effect in the release of toxic materials into the environment, endangering both the ecosystem & social well-being. Building a facility with enough capacity to manage the anticipated sewage flow and lowering sewage output by encouraging water conservation and recycling are two tactics that may be used to avoid overflowing by damaging the microorganisms that break down sewage, toxic compounds in sewage can reduce handling facilities' effectiveness and cause pollutants to leak out. Additionally, they have the potential to harm equipment, raising maintenance and operating expenses. Lead; mercury; and cadmium are examples of heavy metals that are harmful to infrastructure and microbes. Handling may also be hampered by organic contaminants such as insecticides and thinners. Pre-handling is the main method used to lessen the impression of toxic compounds by keeping them out of the sewage system. Toxins & pathogens can be eliminated by chemical handling, however this method raises environmental issues. For enable the all-encompassing advantages of manure handling, alternative technologies including membrane bioreactors, artificial swamps, and anaerobic ingestion can efficiently eliminate contaminants. By gathering data on a variety of factors, supervisory control & data acquisition systems, make it possible to identify issues early and take remedial action. Additionally, they can aid in handling process optimisation by automatically modifying waste fluid flow and chemical doses. Computerised stoppages in the case of problems, such excessive temperatures, also enhance safety. Among the many advantages of programmable logic controllers are less environmental impact, enhanced public health due to fewer infections, and energy and water saving. Sewage handling plants can run and maintain themselves more smoothly by using these methods. The results revealed that adoption of automation system will boost the business performance. The results indicated in this study are limited to the region of the study area it may differ time to time and one area to other.

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