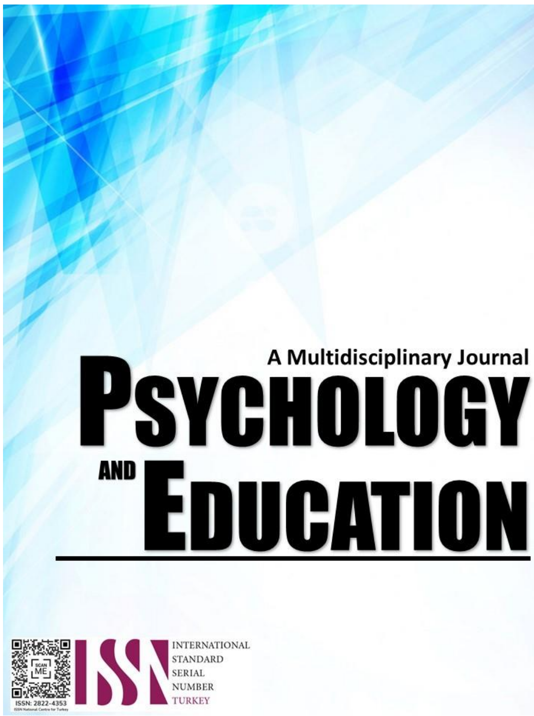
SYSTEM TECHNOLOGY MANAGEMENT OF DRAINAGE SYSTEM AS BASIS FOR ADOPTION



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Research Article

System Technology Management of Drainage System as Basis for Adoption

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Abstract

The study was conducted at Cebu Technological University- Pinamungajan Campus Pinamungajan, Cebu, Philippines in order to develop and install a Perforated PVC Drainage System and determine its acceptability and effectiveness of the Technology Management of Drainage System during the academic year 2019-2020. The Technology Management of the Drainage System for Campus Maintenance was evaluated on its Effectiveness, Sustainability, Awareness, Safety, and Health acceptability. Using a purposeful sample strategy, drainage system technology management experts were chosen, assuring adequate data and participants. A survey was conducted to gather primary data on drainage system technology management, focusing on current practices, challenges, and factors influencing adoption. Descriptive statistics were used to summarize the sample's characteristics. Gathered data were treated using total weighted points, weighted mean, and t-test. Based on the findings and after careful analysis and interpretation of the study, it is concluded that the Technology Management of the Drainage System meets the National Building Code of the Philippines and the Plumbing Code of the Philippines standards for school campuses. It was found that the Technology Management of the Drainage System was HIGHLY ACCEPTABLE in terms of acceptability of its Effectiveness, Awareness, Safety, and Health. It is recommended that the Technology Management of Drainage Systems be adopted and practiced for the maintenance and safety of the end users.

Keywords: *perforated pvc pipes, catch basin, technology management, effectiveness, awareness, pinamungajan cebu*

Introduction

The world of construction technology has developed alternative materials to support daily operations in the workplace (Karakhan et al., 2019). The very reason for this reality is to utilize the available resources. In other words, this employs a technique for this matter. Construction techniques reduce already formed volumes of water and contaminants, such as tanks and detention ponds. Fresco (1994) attributes the growing challenges and difficulties in land use planning, "…notwithstanding the great technological advances and our increased knowledge of the natural resources base" to several factors, such as the diversity of land users; the diversity of goals in the planning process; future uncertainties and model limitations. Effective management of drainage systems is crucial for maintaining the sustainability and functionality of urban environments. As cities grow and face increasing climate change and urbanization challenges, robust and efficient drainage systems are paramount.

Integrating technology into drainage systems in urban areas holds immense potential for effective management. By incorporating real-time monitoring, intelligent control systems, data analytics and modelling, predictive maintenance, and integrated management systems, drainage systems can be optimized for efficient operation (Görür et al., 2021). Remote control and automation enable quick responses to changing conditions, while sustainable practices like rainwater harvesting promote resource conservation. Citizen engagement through technology facilitates awareness and participation. However, cost, interoperability, data privacy, and cyber security considerations must be addressed for successful implementation. Overall, technology management in drainage systems offers a comprehensive approach to improve functionality, maintenance, and sustainability in urban areas. Urbanization rapidly transforms landscapes and pressures existing infrastructure, including drainage systems.

The conventional drainage systems designed to handle moderate rainfall are often overwhelmed during extreme weather events, leading to flooding, property damage, and disruption of daily life. As a result, there is a growing recognition of the need for innovative approaches to manage drainage systems. System technology management, which focuses on integrating technological advancements into system design and operation, holds promise in addressing the challenges faced by drainage systems in urban areas. The construction personnel displays all detailed plans inside the office for you to get more information and monitoring of the projects (Eggimann et al., 2017). The Project schedules also display on the board for daily monitoring of activities. The designated project in charge has always instructed the designated foreman and lead man for every activity on that day of operations.

In Vladivostok, Russia, a remarkable project is underway to develop a university with 21 buildings, roads, bridges, and sports facilities. The primary objective of this project is to provide young Asian students with educational opportunities through scholarships. The construction, scheduled to be completed within 36 months, involves a diverse workforce comprising skilled workers from Asia. Interestingly, the construction technology used in this project is similar to that employed in the Philippines, with minor changes in processes and procedures. The overarching goal is to maximize construction productivity by reducing personnel hours, materials, equipment usage, and human resources while increasing overall production. Innovation is actively encouraged and shared among the construction crews and personnel involved to achieve this (Swan et al., 1999). This can be achieved by establishing cross-functional teams, providing training and development opportunities, and creating platforms for sharing ideas and best practices.

Recognition and rewards for innovation, regular collaboration, and communication further promote knowledge exchange. Embracing technology, partnering with external stakeholders, and learning from mistakes are additional strategies to drive innovation and improve the construction industry. To accomplish the ambitious objectives of this development project, it is crucial to leverage the advancements in construction technology. Various innovative approaches can be employed, including Building Information Modeling (BIM), prefabrication and modular construction, automation and robotics, and sustainable practices (Li et al., 2019). Adopting these technologies and practices can enhance efficiency, quality, and sustainability. Furthermore, sharing these innovations with the construction crews and personnel ensures continuous improvement and the optimization of construction processes. This project in Vladivostok exemplifies the importance of integrating technology and innovation to succeed in construction projects and deliver high-quality education infrastructure for aspiring students. The construction sectors today have encountered drainage system problems. Sixty (60%) percent of the project cost will go to the drainage system. The urban drainage system allows rainwater to flow out until it reaches watercourses.

However, a more efficient look at this system is needed so that the flow does not negatively impact the downstream areas, balancing the responsibilities of system users, which is possible with sustainable drainage technologies in which flow reduction and delay are valued (Vicente et al., 2023). In other words, sustainable drainage technologies are needed to balance the responsibilities of system users and reduce flow. Along with clean water pipes, sewers are a vital element in the "sanitary revolution," which is based on passive protection against health hazards by separating clean and dirty water and has been considered among essential medical milestones since 1840 (Ferriman, 2007) . In every site development, there was a cut and fill of soil. The developer considers the land's slope for the drainage system's direction (Hernando & Romana., 2015). Most developers will follow the drainage system layout and construction right after the lot subdivision. The road construction inside the subdivision will also be constructed. The road construction and the drainage system will go together with catch basic and the Reinforced Concrete Pipes (RCP) (Ximenes et al., 2020).

The researchers conducted a study to innovate the drainage system at the Cebu Technological University-Pinamungajan Campus to prevent floods within the campus. The existing drainage system was enhanced to catch ground rain using perforated pipes. The study utilized several materials, including cement, sand, gravel, water, reinforced bars, and Polyvinyl Chloride (PVC). By implementing this innovative perforated drainage system, the researchers aimed to address the problems associated with the previous drainage system. The researchers partially answered the problems encountered by constructing a Perforated Drainage System based on the Development Plan of CTU- Pinamungajan Campus.

Research Questions

This research study assessed the effectiveness of the Drainage System Technology Model at Cebu Technological University-Pinamungajan Campus, Pinamungajan Cebu during the Academic Year 2019-2020 as basis for adoption. Specifically, it sought answers to the following:

1. What are the prior arts related to drainage system?
2. What are the technical requirements for development of the drainage system as to:
    2.1. design;
    2.2. process;
    2.3. cost; and
    2.4. safety?
3. As rated by the respondent-groups, What is the level of effectiveness of the developed drainage system as to the aforementioned requirements:

3.1. design;
3.2. process;
3.3. cost; and
3.4 safety?
4. What is the performance of the drainage system as compared to the conventional drainage system?
5. As evaluated by the respondent-groups to what extent is the acceptability of the drainage system based on TAMS constructs?
6. Based on findings what technology model can be adopted?

Literature Review

It must be noted that there were many previous studies conducted by various research scholars about drainage systems in construction sites. The issue of sustainable development is now high on the global agenda, but there is still considerable uncertainty in its definition and implementation. This study aimed to reappraise the provision of urban drainage services in light of this current debate. The approach advocated is not striving for the unattainable goal of completely sustainable drainage but actively promoting "less unsustainable" systems. To do this requires both an understanding of the long-term and widespread impacts of continuing current practices and an understanding of the implications of making changes. Sustainable urban drainage should

- maintain a sound public health barrier,
- avoid local or distant pollution of the environment,
- minimize the utilization of natural resources (e.g., water, energy, materials), and
- be operable in the long-term and adaptable to future requirements (Butler & Parkinson, 1997).

Sustainable Urban Drainage Systems (SUDS) is a collection of practices and techniques to manage environmentally friendly and sustainable stormwater runoff in urban areas. SUDS mimic natural drainage processes and mitigate the negative impacts of urbanization on water quality, flooding, and ecosystems. They include permeable surfaces, green roofs, rain gardens, bioretention basins, swales, detention and retention ponds, and water recycling. By implementing SUDS, cities can improve water quality, reduce flood risks, enhance biodiversity, and create appealing green spaces (Rodríguez et al., 2014). SUDS also contribute to climate change adaptation by mitigating heavy rainfall effects and enhancing water resilience. Successful implementation of SUDS relies on local regulations, urban planning, and community involvement to raise awareness and encourage individual actions toward sustainable water management.

Several studies emphasize the importance of integrated drainage system management, which involves integrating various components, such as sensors, data collection systems, and decision support tools. These integrated systems enable real-time monitoring, analysis, and proactive decision-making, improving drainage system performance. Advancements in sensor technologies have played a vital role in drainage system management. Literature highlights the use of various sensors, including water level sensors, rainfall sensors, and flow sensors, to gather real-time data on drainage system performance. These sensors enable the early detection of potential issues, allowing authorities to take timely preventive measures. The availability of large volumes of data from drainage systems has prompted the development of data collection and analysis techniques. Studies utilize data-driven methodologies for historical data evaluation and system forecasting. These techniques aid in identifying patterns, optimizing system operation, and predicting potential drainage system failures.

Based on the study of David Butler and Jonathan Parkinson (1997), three strategies are proposed that can be carried out immediately, incrementally, and effectively. These are to reduce potable water "use," to reduce and eliminate the mixing of industrial wastewater with domestic waste, and to reduce and then eliminate the mixing of stormwater and domestic wastewater (Butler & Parkinson, 1997). Several techniques are described that may allow the adoption of these strategies, many of them small-scale source control technologies. An incremental approach containing high-tech and low-tech answers to appropriate problems is the most likely to be implemented, but each case must be decided on its merits. Reducing potable water use is essential for sustainable living, and there are numerous strategies you can implement to achieve this goal. Firstly, promptly fix any leaks in your plumbing system, as even minor leaks can waste a significant amount of water over time. Secondly, replace old toilets, showerheads, and faucets with water-efficient models with the WaterSense label.

Additionally, invest in water-saving appliances like dishwashers and washing machines designed to use less water while maintaining their functionality. Implement water-wise landscaping practices such as xeriscaping, use efficient irrigation systems like drip irrigation, and collect rainwater in barrels for watering plants (Brown, 2007). Installing dual-flush toilets can help conserve water by offering different flush options for solid and liquid waste. Shortening your shower duration and using low-flow showerheads further reduce water consumption. Collecting and treating greywater for non-potable uses is another effective strategy. Always wait for a full load before running dishwashers and washing machines. Educate and raise awareness about water conservation within your community. Monitor your water usage and identify areas for improvement. Harvest rainwater from your roof and use it for non-potable purposes. Adopt water-efficient dishwashing and handwashing techniques. Insulate hot water pipes to minimize heat loss and reduce the need to let the faucet run. Opt for water-efficient cooking methods and reuse cooking water. Participate in community initiatives that promote water conservation. By implementing these strategies, you can contribute to a more sustainable future by reducing potable water use (EL-Nwsany et al., 2019).

Severe issues in urban storm drainage systems include overflows, maintenance holes, geysers, and structural damages. A storm sewer tunnel in the system may be pressurized if its conveyance capacity is exceeded or if it is also used for storage. The pressurization process is associated with the movement of a surge that separates the free-surface flow regime from the pressurized flow regime. Analysis of the surge movement characteristics revealed that the surging strength at the end of the pressurization process determines the extent of the surge problems. Operational and structural methods to reduce the surging strength are proposed and evaluated for the Mainstream and O'Hare System of the Tunnel and Reservoir Plan in Chicago, Illinois (Guo & Song, 1990). They include inflow regulation, initial storage regulation, use of a downstream reservoir, and use of an upstream surge tank.

Today, the main concepts required for describing drainage dynamics in an entire urban area are known, and models are available that can reasonably simulate the behavior of the urban water system. Still, such integrated modeling is a complex exercise not only due to the sheer size of the model but also due to the different modeling approaches that reflect the history of the sub-models used and the purpose they were built for. The study reviews the state of the art in deterministic modeling, outlines experiences, and discusses problems and future developments.

According to Hipp et al. (2006), the device, methods, and media for filtering liquids are especially suited for insertion into an existing stormwater catch basin. The filtration that occurs reduces the concentration of stormwater runoff pollutants, including heavy metals, suspended solids, particles, and oil and grease. While being able to handle the high flow rates of stormwater runoff, the filters also remove small particles and oil and grease the filters are arranged such that overflow from the uppermost filters, as they become clogged, is directed by overflow weirs to change direction to allow filtration by lower filters. Stormwater surges during peak intensity can overflow directly into a catch basin to prevent ponding. The invention can also be used above ground to treat pumped liquid from industrial and environmental sources.

A principal catch basin defining a specific storage capacity, the catch basin is situated below the level of the ground, having an upper-level opening for receiving surface water drainage thereunto and having side walls partially constructed of permeable geotextile fabric for allowing both sub-surface breaths of air to flow into the catch basin for providing additional water absorption by the ground, and for allowing water flow and sub-surface air to flow into the catch basin for providing additional water absorption by the ground, and for allowing water flow into the sub-surface water flow through the permeable basin to serve as a collection for sub-surface drainage. The system would include the ability to create a siphon within the system so that as water drains into the central collection basin, the water may be automatically siphoned to a distant exit point or an exit cylinder so that there is a constant movement of water from the principle collection point to the distant exit point (Mays, 2008). In addition, a plurality of collection basins may siphon into the central collection basin, which would then siphon into the distant exit point.

Methodology

In this research, a cross-sectional study design was used to collect data at a specific point in time. This design allows for examining variables and their relationships simultaneously without requiring follow-up or longitudinal data collection. The cross-sectional approach is appropriate for investigating the current state of system technology management in drainage systems and its relationship with adoption. The study targeted professionals managing, planning, and implementing drainage systems, including engineers, policymakers, and relevant stakeholders. A purposive sampling technique selected participants with knowledge and experience in drainage system technology management. The sample size for this research study was determined based on data saturation, ensuring enough participants were included to achieve data adequacy. A questionnaire survey was conducted to gather primary data on drainage system technology management, including current practices, challenges, and factors influencing adoption. Survey questionnaires were distributed to 10 professors, 45 students, and five experts for evaluation and interviews, utilizing statistical techniques. The characteristics of the sample and the answers to each question were summarized using descriptive statistics, such as frequencies, percentages, and means.

Ethical approval was sought from the relevant institutional review board to ensure participant privacy, informed consent, and data confidentiality. Participants were informed about the purpose of the study, their rights, and the voluntary nature of their participation. All data collected were anonymized and securely stored to maintain confidentiality and protect participants' identities. This study was conducted at Cebu Technological University, a certified Center of Excellence for Technology Education in Cebu City, Philippines. The university, previously known as Cebu State College of Science and Technology, is ISO 9001:2008 certified.

Results and Discussion

This research study sought to manufacture, install and determine the effectiveness of the Technology Management of Drainage System using the Reinforced Concrete Catch Basin and the Perforated PVC Pipes Drainage System at the Cebu Technological University-Pinamungajan Campus, Pinamungajan, Cebu during School Year 2019-2020.

The result from the questionnaires answered by the respondent-groups in this research study was very precise and accurate. The result of the Technology Management of Drainage System survey in the identified by the respondent-groups in Pinamungajan Cebu, Philippines was also been discussed.

The information was collected by means of questionnaires completed by both respondents-Groups: Students, Faculty and experts from small scales industries with the total of 95 respondents.

The Prior Arts Related to Drainage System

Drainage systems, called river systems in geomorphology, are the patterns created by the streams, rivers, and lakes in a specific drainage basin. The land's topography governs them, whether hard or soft rocks, and the gradient of the land dominate a particular region.

The systems in your home are essentially the same, whether on a septic or sewer system. Supply systems rely on pressure, while drainage systems do not. Instead, waste material exits your home due to the drainage pipes' downward slant. The trash is moved along by gravity. The sewer line maintains this downward flow to a septic tank or sewage treatment facility.

The system has more to it than it first appears, including vents, traps, and cleanouts. Your home's roof has protruding vents, letting air into the drain pipes. Water in the traps would need to be drained if there were no air supply from the vents since wastewater would not discharge properly.

The Technical Requirements for Development of the Drainage System as to: Design, Process, Cost; and Safety.

The Technical Requirement for the development of the Drainage System was consider the following: The Design of the drainage system, the procedures of fabrication and installations, the material and labour costs, and the required safety during the construction of the drainage system. This research study was very unique because, when the rain water over flows from the surface of the ground the excessed water will be absorbed down directly to the perforated PVC pipes installed underground. The development of a drainage system requires careful consideration of technical requirements in terms of design, process, cost, and safety (Van der Molen et al., 2007). Design aspects include determining the system's capacity, planning the layout, ensuring appropriate slopes and gradients, and selecting durable materials. The process involves site assessment, obtaining permits, planning construction methodology, and establishing maintenance procedures. Cost requirements involve budgeting, cost estimation, and value engineering to optimize cost-efficiency. Safety considerations encompass flood prevention, erosion control, adherence to safety standards, and integration with existing infrastructure. Consulting with experts and authorities is essential to meet these requirements, which may vary depending on location and regulations.

Implementing a drainage system requires an integrated approach that addresses technical requirements in design, process, cost, and safety. It involves planning the system's capacity, layout, slopes, and materials while considering factors such as water flow, rainfall intensity, and catchment area (Dahal et al., 2008). The construction process requires site assessment, permitting, and careful execution of excavation, pipe laying, and backfilling. Cost considerations involve budgeting, estimating expenses for materials, labor, and maintenance, and exploring cost-effective options. Safety measures include flood prevention, erosion control, compliance with safety standards, and safeguarding existing infrastructure. Collaboration with experts and adherence to local regulations are essential to ensure an effective, efficient, and safe drainage system is developed.

Table 1. *Design N= 95*

Technical Requirements In terms of Design	*VHE* 5	*VE* 4	*E* 3	*LE* 2	*NE* 1	*X*	*VD*
1.1. Road drainage design has as its basic objective the reduction and/or elimination of energy generated by flowing water.	4.20	4.68	4.16	4.20	4.20	4.288	VHE
1.2. Provision for adequate drainage is of paramount importance in road design and cannot be overemphasized.	4.22	4.88	4.18	4.22	4.22	4.344	VHE
1.3. Hydrologic factors to consider in locating roads are number of stream crossings, side slope, and moisture regime.	4.18	4.48	4.18	4.18	4.18	4.240	VHE
1.4. Hill slope geomorphology and hydrologic factors are important considerations in the location, design, and construction of a road.	4.16	4.68	4.16	4.16	4.16	4.260	VHE
Total:	4.19	4.68	4.17	4.19	4.19		
Interpretation:	Very Effective						
Rank:	3	1	2	3	3		

In Table 1, there were 4 technical requirements in terms of design. 1st stays "Road drainage design has as its basic objective the reduction and/or elimination of energy generated by flowing water." 2nd Provision for adequate drainage is of paramount importance in road design and cannot be overemphasized; 3rd Hydrologic factors to consider in locating roads are number of stream crossings, side slope, and moisture regime and the 4th Hill slope geomorphology and hydrologic factors are important considerations in the location, design, and construction of a road. Based on the results rated by the respondent-groups, there were 2 rated as rank # 1 the provision for adequate drainage is of paramount importance in road design and cannot be overemphasized and for Rank # 2 Road drainage design has as its basic objective the reduction and/or elimination of energy generated by flowing water and Rank # 3 Hill slope geomorphology and hydrologic factors are important considerations in the location, design, and construction of a road; and Rank #4 Hydrologic factors to consider in locating roads are number of stream crossings, side slope, and moisture regime.

Therefore, the implication of these table Technical Requirements In terms of Design was *"Very Effective"*. Butler and Parkinson's study (1997), emphasized sustainable urban drainage's importance for maintaining public health, avoiding environmental pollution, minimizing resource utilization, and being long-term and adaptable. According to Marsalek et al (1993) it is also imperative to say that design and operation of urban drainage systems are addressed in the context of the urban water system comprising drainage, sewage treatment plants and receiving waters. The planning and design of storm sewers are reviewed with reference to planning objectives, design objectives, flows and pollutant loads, sewer system structures and urban runoff control and treatment.

Table 2. *Process N= 95*

Technical Requirements In terms of Process	*VHE* 5	*VE* 4	*E* 3	*LE* 2	*NE* 1	*X*
2.1. Correct Procedures in excavating of soil for Catch Basin and Perforated PVC Pipes.	4.20	4.68	4.16	4.20	4.20	4.288
2.2. Distances of Perforated holes of PVC pipes and sloping percentage.	4.16	4.68	4.16	4.16	4.16	4.260
2.3.Proper installation of Reinforced Concrete Pipes as Catch Basin.	4.20	4.68	4.16	4.20	4.20	4.288
2.4. Correct installation of Geotextile Fabric and gravel inside the Fabric.	4.18	4.48	4.18	4.18	4.18	4.240
Total:	4.185	4.63	4.165	4.185	4.185	

As presented in Table 2, there were 4 technical requirements in terms of design. 1st stays "Correct Procedures in excavating of soil for Catch Basin and Perforated PVC Pipes." 2nd Distances of Perforated holes of PVC pipes and sloping percentage; 3rd Proper installation of Reinforced Concrete Pipes as Catch Basin and the 4th correct installation of Geotextile Fabric and gravel inside the Fabric.

Based on the results rated by the respondent-groups, there were 2 rated as rank # 1 the Correct Procedures in excavating of soil for Catch Basin and Perforated PVC Pipes and Proper installation of Reinforced Concrete Pipes as Catch Basin; for Rank # 2 correct installation of Geotextile Fabric and gravel inside the Fabric. And Rank # 3 Distances of Perforated holes of PVC pipes and sloping percentage.

Therefore, the implication of these table Technical Requirements In terms of Process was *"Very Highly Effective".* It has been proven to be efficient because during the long-term drainage process of the geotextile, the fine particles very easily enter the geotextile and are adsorbed on the pores, which leads to the continuous decline of the drainage in the geotextile over time (Zhang et al., 2023).

Table 3. *Cost N= 95*

Technical Requirements In terms of Cost	*VHE 5*	*VE 4*	*E 3*	*LE 2*	*NE 1*	*X*
3.1. Site manufacturing of Catch Basin, Covers and Concrete Based Plate.	4.18	4.48	4.18	4.18	4.18	4.240
3.2. PVC pipes for drainage and fittings.	4.20	4.68	4.16	4.20	4.20	4.288
3.3. Excavation Equipment, fine aggregates and coarse aggregates applied.	4.20	4.68	4.16	4.20	4.20	4.288
3.4. Geotextile Fabric and backfilling materials used.	4.20	4.68	4.16	4.20	4.20	4.288
Total:	4.19	4.63	4.165	4.195	4.195	

As presented in Table 3, there were 4 technical requirements in terms of design. 1st stays "Site manufacturing of Catch Basin, Covers and Concrete Based Plate; " 2nd PVC pipes for drainage and fittings; 3rd Excavation Equipment, fine aggregates and coarse aggregates applied and the 4th Geotextile Fabric and backfilling materials used.

Based on the results rated by the respondent-groups, there were 3 rated as rank # 1 PVC pipes for drainage and fittings, Excavation Equipment, fine aggregates and coarse aggregates applied, and Geotextile Fabric and backfilling materials used.; for Rank # 2 Site manufacturing of Catch Basin, Covers and Concrete Based Plate.

Therefore, the implication of these table Technical Requirements In terms of Cost was *"Very Highly Effective".* The findings is in line with the previous study conducted by Yazdanfar and Sharma (2015), who firmly argued that it is necessary to establish a cost-effective, integrated planning and design framework for every local area by incorporating fit for purpose alternatives.

Table 4. *Safety N= 95*

Technical Requirements in terms of Safety	*VHS 5*	*VS 4*	*S 3*	*LS 2*	*NS 1*	*X*	*VD*
4.1. Fabrication of Perforated PVC Pipes.	4.20	4.68	4.16	4.20	4.20	4.288	VS
4.2. Manufacturing of Reinforced Concrete Pipes	4.18	4.48	4.18	4.18	4.18	4.240	VS
4.3. Installation of Catch Basin and Pipes.	4.18	4.48	4.18	4.18	4.18	4.240	VS
4.4. Backfilling of soil using hydraulic excavator.	4.18	4.48	4.18	4.18	4.18	4.240	VS
Total:	4.185	4.53	4.175	4.185	4.185		
Interpretation:			Very Safe				

As presented in Table 4, there were 4 technical requirements in terms of design. 1st *stays "Fabrication of Perforated PVC Pipes; " 2nd Manufacturing of Reinforced Concrete Pipes; 3rd Installation of Catch Basin and Pipes and the 4th Backfilling of soil using hydraulic excavator.*

Based on the results rated by the respondent-groups, there were 1 rated as rank # 1 Fabrication of Perforated PVC Pipes; for Rank # 2 Site manufacturing of Catch Basin, Covers and Concrete Based Plate, Manufacturing of Reinforced Concrete Pipes, Installation of Catch Basin and Pipes and the Backfilling of soil using hydraulic excavator.

Therefore, the implication of these table Technical Requirements In terms of Safety was "Very Highly Effective". *While in all aspect of human welfare, safety has been the most priority. This recent study's finding has been conformed with the previous study of Kang et al. (2016) who argued that system improvement should be preceded by an evaluation of drainage system capacity and so as to increase safety by improving the drainage system or the operation such as LID (Low-Impact Development), SUDS (Sustainable Drainage Systems), WSUD (Water-Sensitive Urban Design), GSI (Green Stormwater Infrastructure) etc., without reinforcing the disaster-prevention criteria.*

To sum up, technical specifications for drainage systems include design, procedure, cost, safety, and considerations like capacity, slope, catchment area, and integration. Process requirements include survey, analysis, laws, construction, quality control, maintenance, cost estimation, stormwater management, safety standards, accessibility, and hazard mitigation. Designing a reliable drainage system requires specialists and local laws.

The Level of Effectiveness of the Developed Drainage System

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The effectiveness of a developed drainage system can be evaluated based on various factors. These include the design and capacity of the system to handle the anticipated volume of water, preventing or minimizing flooding incidents, facilitating smooth water flow, regular maintenance and cleaning to ensure proper functioning, minimizing environmental impact through erosion control and water quality protection, and stakeholder satisfaction. A well-designed system that efficiently collects and transports water, prevents flooding, and requires regular maintenance and cleaning is more likely to be effective. Additionally, considering the system's environmental impact and incorporating feedback from stakeholders can contribute to assessing its overall effectiveness. Ongoing monitoring and necessary adjustments can further enhance the system's performance and effectiveness over time.

Table 5. *Level of Effectiveness N= 95*

Level of Effectiveness of the Developed Drainage System	*VHE* 5	*VE* 4	*E* 3	*LE* 2	*NE* 1	*X*	*VD*
5.1. Design	4.19	4.68	4.17	4.19	4.19	4.280	VHE
5.2. Process	4.185	4.63	4.165	4.185	4.185	4.270	VHE
5.3. Cost	4.19	4.63	4.165	4.195	4.195	4.275	VHE
5.4. Safety	4.185	4.53	4.175	4.185	4.185	4.252	VHE
Total:	4.187	4.617	4.168	4.188	4.188	4.252	
Interpretation:	Very Highly Effective						

The Table 5, there were 3 Level of Effectiveness of the Developed Drainage System: 1. Design, 2. Process, 3. Cost, 4. Safety. Based on the results as rated by the respondent-groups there were 4.280 as to "DESIGN"; 4.270 AS Process; 4.275 as to Cost and 4.252 as to Safety. Therefore, the interpretation of the table above was "Very Highly Eefective". While it is true that waterlogging is common because of heavy rains, in this case, the drainage system can no longer meet the original design requirements, resulting in traffic jams and even paralysis and post a threat to people safety. Therefore, it provides a necessary foundation for system drainage planning and design to accurately assess the capacity of the drainage system and correctly simulate the transport effect of drainage network and the carrying capacity of drainage facilities. This recent study has been conformed to the previous study which was found that the simulation and analysis results of the drainage system model were reliable. They could fully reflect the service performance of the drainage system in the study area and provide decision-making support for regional flood control and transformation of pipeline network (Peng et al., 2015).

The Performance of the Drainage System as Compared to the Conventional Drainage System

In a conventional network, the minor drainage system is usually a pipeline with sufficient capacity to contain the nuisance flows. These pipelines prevent storm water damage to properties and also limit the frequency and quantity of surface water to a level acceptable to the community. They're usually designed to cater for flows with a five year average recurrence interval (ARI). The pipelines don't always follow the natural drainage path and are usually aligned along property boundaries and the roadway curb and channels. While the Perforated PVC Pipe Drainage System water runs by or through the yard, or water pools and seeps into places we don't want it to go. Homeowners rarely see the underground drainage system in their yards or under our roads. There are buried pipes that continuously flow water out of our homes from sinks and toilets. Each home also has perimeter drain pipe buried at the base of the home's foundation to drain water away from the foundation. In many gardens people have installed small catch basins to collect water or buried drain pipes under lawns and wet areas for drainage. Knowing how to maintain or repair a drainage system is a useful skill to have for anyone living on our watery planet.

Table 6. *Conventional Drainage System and the Reinforced Concrete Catch Basin and Perforated PVC Pipe Drainage System N=95*

Performance of the Drainage System	*VHE* 5	*VE* 4	*E* 3	*LE* 2	*NE* 1	*X*	*VD*
Perforated Drainage System	4.20	4.68	4.16	4.20	4.20	4.288	VHE
Conventional Drainage System	4.18	4.48	4.18	4.18	4.18	4.240	VHE
Total:	4.19	4.58	4.17	4.19	4.19	4.264	VHE
Interpretation:	Very Highly Effective						

As indicated in Table 6, Conventional Drainage System and the Reinforced Concrete Catch Basin and Perforated PVC Pipe Drainage System there were 2 Performance of the drainage system: 1st is *Perforated Drainage System and 2nd is Conventional Drainage System. Based on the survey results, the respondents rated the Perforated Drainage System as "Very Highly Effective" to the actual performance during rainy seasons. The finding of this study has been corroborated with the previous study conducted by Abbott and Comino-Mateos (2003), who posited that clearly then there is a growing awareness that sustainable drainage systems can offer a more*

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Research Article

sustainable option for the management of stormwater runoff than conventional drainage systems. Through this process, infiltration tests provided information on the processes of water entry into the pavement system and impacts of clogging on hydraulic performance.

Acceptability Of The Drainage System Based On Tams Constructs

The technology acceptance model (*TAM*) is an information systems theory that models how ... critical of the measurement model used, and postulated a different model based on three *constructs*: usefulness, ease-of-use and the Client's Satisfaction.

Table 7. *Perceived Usefulness N= 95*

Acceptability of the Drainage System as to Usefulness	*VHA*	*VA*	*A*	*LA*	*NA*	*X*	*VD*
	5	*4*	*3*	*2*	*1*		
Help to catch rain water from floods.	*4.88*	*4.60*	*4.14*	*4.14*	*4.10*	*4.37*	*VHE*
Help waste water from households.	*4.20*	*4.68*	*4.16*	*4.20*	*4.20*	*4.288*	*VHE*
Protect erosions.	*4.18*	*4.48*	*4.18*	*4.18*	*4.18*	*4.240*	*VHE*
Total:	*4.42*	*4.58*	*4.16*	*4.17*	*4.16*		
Interpretation:	*Very Highly Effective*						
Rank:	*2*	*1*	*4*	*3*	*4*		

As presented in Table 7, Perceived Usefulness the respondents rated according to *"Acceptability Of The Drainage System As To Usefulness" Rank 1 Help to catch rain water from floods; Rank 2 Help waste water from households and Rank 3 Protect erosions.*

Therefore, the implication of these table presented above was" Very Highly Acceptable". This recent study is in line with the objective of the study conducted by Ignacio et al. (2019) who were able to develop and test a theoretical model grounded in technology acceptance, diffusion of innovation and organizational theories to identify factors that influence attitudes of local jurisdiction officials toward adoption of green infrastructure for stormwater management.

Table 8. *Perceived Ease of Use N= 95*

Acceptability of the Drainage System as to Ease of Use	*VHE*	*VE*	*E*	*LE*	*NE*	*X*	*VD*
	5	*4*	*3*	*2*	*1*		
Easy to clean the Catch Basin.	4.88	4.60	4.14	4.14	4.10	4.37	VHE
Fast absorption of Rain Water.	4.20	4.68	4.16	4.20	4.20	4.288	VHE
Easy to Maintain the drainage system.	4.18	4.48	4.18	4.18	4.18	4.240	VHE
Total:	4.42	4.58	4.16	4.17	4.16		
Interpretation:	Very Highly Effective						

As indicated in Table 8, there were 3 Acceptability of the Drainage System as to Ease of Use rated by respondent-groups. Rank 1 *Easy to clean the Catch Basin.; Rank 2 Fast absorption of Rain Water; and Rank 3 Easy to maintain the drainage system.*

Therefore, the result of the table presented above was "Very Highly Effective"

Table 9. *Client's Satisfaction N= 95*

Acceptability of the Drainage System as to Client's Satisfaction	*VHE*	*VE*	*E*	*LE*	*NE*	*X*	*VD*
	5	*4*	*3*	*2*	*1*		
Nice to see the formation of the Catch Basin.	4.88	4.60	4.14	4.14	4.10	4.37	VHE
Comfort ability to walk above the drainage line.	4.20	4.68	4.16	4.20	4.20	4.288	VHE
Safe to walk during floods or rainy seasons.	4.18	4.48	4.18	4.18	4.18	4.240	VHE
Total:	4.42	4.58	4.16	4.17	4.16		
Interpretation:	Very Highly Effective						
Rank:	2	1	4	3	4		

As indicated in Table 9, there were 3 Acceptability of the Drainage System as to Client's Satisfaction rated by respondent-groups. Rank 1 *Nice to see the formation of the Catch Basin; Rank 2 Comfort ability to walk above the drainage line and Rank 3 Safe to walk during floods or rainy seasons.*

Therefore, the result of the table presented above was "Very Highly Effective". The recent study has been corroborated with the previous study conducted by Naspetti et al. (2017), who found that perceived usefulness is the key determinant of acceptance, while the intention to adopt a sustainable production strategy…in the adoption of innovations. Finally, the perceived usefulness of all of the investigated strategies is higher for organic farmers, while collaborative patterns reduce the impact of subjective norm on usefulness and overall acceptance. Our *findings should encourage policy makers to consider the important role of supply chain management practices, including collaboration, to enhance the sustainability of drainage system.*

Conclusion

Based on the findings and after a careful analysis and interpretation of the research study, it is concluded that the Technology Management of Drainage System meets the required standards and is precise guide in Campus Maintenance System. The plans applied for this technology management of drainage system create positive impact not only to the system itself but also to other system within water management system. The research on system technology management of drainage systems has demonstrated the potential for widespread adoption of advanced technologies in this field. The study highlighted the numerous benefits of adopting these technologies, including improved efficiency, enhanced flood control, reduced environmental impacts, and increased resilience to climate change. However, it also identified several challenges that need to be addressed, such as high initial costs, limited technical knowledge, fragmented governance structures, and regulatory barriers. Overcoming these challenges requires collaborative efforts from multiple stakeholders, including government agencies, utility providers, researchers, and the community. Strategic planning, stakeholder engagement, and continuous monitoring were emphasized as crucial elements for successful adoption and long-term sustainability.

In summary, the research findings underscore the importance of embracing advanced drainage system technologies to improve overall system management. By addressing the challenges and capitalizing on the benefits, communities can enhance their resilience to climate change, mitigate flood risks, and protect the environment. Future research should focus on addressing the identified challenges, evaluating the long-term impacts of adopted technologies, and exploring innovative solutions to further enhance drainage system management. By doing so, we can continue to improve the efficiency and effectiveness of drainage management, leading to sustainable and resilient communities.

It is recommended that the Technology Management of Drainage System be adopted and practice for maintenance personnel. Adopting and practicing Technology Management of Drainage Systems is highly recommended for maintenance personnel as it brings numerous benefits. Effective management of drainage systems is crucial for preventing flooding, erosion, and related issues. Technology management involves utilizing technological tools and practices to enhance maintenance and operation. By adopting this approach, maintenance personnel can benefit from improved monitoring and inspection through the use of remote sensing techniques like satellite imagery and aerial surveys to identify potential issues and plan proactive maintenance. Efficient data collection and analysis can be achieved through sensor networks that monitor water levels, flow rates, and other parameters in real-time, allowing maintenance personnel to detect abnormalities and make informed decisions. Predictive maintenance can also be implemented by analyzing historical data and using predictive modeling techniques, helping maintenance personnel anticipate maintenance needs and schedule interventions to minimize downtime and reduce costs. Technology also enables better communication and collaboration among maintenance personnel through digital platforms and mobile applications that facilitate information sharing, task coordination, and real-time issue reporting. Integration with Geographic Information Systems (GIS) allows maintenance personnel to visualize and analyze the drainage network in relation to geospatial data, enhancing decision-making and targeted maintenance interventions. Additionally, training programs can be conducted to ensure maintenance personnel acquire the necessary skills and knowledge to effectively utilize technology tools, fostering professional development and increased efficiency in their duties. Overall, the adoption and practice of Technology Management of Drainage Systems empower maintenance personnel to optimize the maintenance and operation of drainage systems, resulting in improved performance and resilience of the infrastructure.

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