

Multi - Water Sources Automation Advancing the CSPC Water Distribution

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RESEARCH ARTICLE

Abstract

A solution for the unstable water supply at CSPC to improve the water distribution system is presented, utilizing a multi-water source control automation system to ensure a reliable and responsive water supply. Multi-Water Source Control Automation tackles challenges from rapid urbanization and population growth in Nabua, Camarines Sur, where clean water sources are limited. This approach leverages multiple water sources like NAWAD Water District, rainwater, and groundwater to address campus water concerns comprehensively. Automation applications face specific challenges in water source control, operation management, and cost reduction, necessitating a thorough assessment of their overall performance by evaluating their effectiveness, reliability, and responsiveness to optimize performance benefits. The result was determined through the development process of a prototype, which is divided into six stages: planning, designing, fabrication, initial evaluation, modification, and final evaluation. The incorporation of automation significantly enhances pressure control within the distribution pump capacity, ensuring consistent pressure levels within specified limits regardless of water flow rates while meeting end-user demands adequately. It also maintains the Main Reservoir Tank at 75% capacity, aligning with design parameters, thanks to the swift response capability of a multi-water source automation system. This advancement in Multi-Water Source Control Automation underscores the critical role of automated water distribution operations in securing a reliable and responsive water supply for various applications within the CSPC campus and in the surrounding community.

Keywords: Automated Control System, Automation, Multi-water Sources, Rain Water Supply, Water Distribution System Automation

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1 INTRODUCTION

The Philippines has enough fresh water; it never disappears, it is always the same, and it is just used repeatedly. However, clean water is becoming less available because of many factors that affect its availability, such as rapid urbanization, lack of infrastructure, pollution, and climate change. These factors stress our natural water cycle and often result in domestic water supply shortages for their growing populations. This same situation holds in Nabua, Camarines Sur, Philippines, where fast urbanization coupled with an annual population increase of 2.48% (2015 - 2021 Population census www.nnc.gov.ph) would increase the demand for water per year. This would greatly concern water input for establishments and businesses in Nabua, Camarines Sur [1].

Considering this situation from the perspective of a learning institution like Camarines Sur Polytechnic College (CSPC), which is situated in Nabua, this water supply problem will intensely be

felt since not only the problem of water supply from a Nabua water district decrease at the same time, the school projected water consumption would also increase due to high enrollment rate every year. Thus, an increase in the student population per year will result in an unstable supply to the user of the campus. The proposed multi-water source approach offers a promising solution. By reducing the dependency on the local water supplier as a primary source, the researchers can mitigate the water problem. Several water sources, such as rain and groundwater, are still not fully utilized [2] [3]. The average precipitation is 219 mm of monthly rainfall, which decreases by almost 66% to 74 mm during summer [4]. Groundwater, abundant in the Bicol region, can replace the volume of water lost from rainwater during summer. However, a regulated extraction may be implemented to ensure sustainability and compliance with government regulations [5]. This approach could revolutionize the water supply system.

Much research has been conducted to illustrate the effectiveness of automation in water distribution systems [6] [7] [8]. In recent years, intelligent Control System techniques have achieved significant development that could be used to integrate different water sources and answer the challenges facing automated multi-source water systems [9] [10] [11]. Significant improvement, especially in areas such as water source control in a multi-source water system, the primary and supplemental sources must be assigned. By applying automation, the source can be controlled automatically. If the primary source, such as rainfall, suddenly runs out, the secondary source was activated immediately, ensuring the system's water availability [12].

In water distribution system operation management, monitoring flows, pressure control, water storage levels, maintenance, and alarm systems can be integrated to manage the water distribution system and identify which components cause problems for easy troubleshooting and quick countermeasures [13] [14] [15] [16]. Automation in water distribution system operation provides real-time intelligent control, monitors the data and signal, and uses software applications that revolutionize the water supply system [17] [18].

Using automation, the cheap but unreliable water source can be used sustainably and efficiently to supply the water distribution system, which is cost-effective in the long run. With these, the researchers developed a study to analyze the effectiveness of multi-source water control automation, emphasizing the importance of "automated plant operation" to ensure a consistent water supply to the user [19].

2 METHODOLOGY

The overall performance of the prototype is measured through the effectiveness of water pressure to maintain equal or above the distribution system requirement: The reliability of maintaining the water level in the main reservoir tank, which the distribution tank will draw the water before delivering it to the end user. The response time the system will react to maintain the water balance between the main reservoir and distribution tank. The development process of a prototype is divided into four stages: planning, designing, fabrication, and evaluation.

2.1 Planning Stage

2.1.1 Data Gathering

The observation and data analysis conducted by the researcher in the water supplied by the Local Water Supplier gathered pertinent information that disclosed the problems and limitations. The pressure data in Figure 1 shows the water pressure and the flowrate rate of the water supply by the water supplier. The data collected are from the pressure gauge and flowmeter connected to the entrance of the CSPC Campus.

By looking closely at the pressure in the entrance from the NAWAD water supply inside the campus, it can be seen that from 5:00 AM to 12 noon, it drops significantly from an average of 3.0 psi, and in the afternoon until midnight, it increases back to a maximum of 10 psi. The highest recorded water pressure from NAWAD is from 12 midnight until 4:00 AM at around 12psi, which gives the highest water flow rate, with an average of $7.4m^3/hour$. The water pressure from early

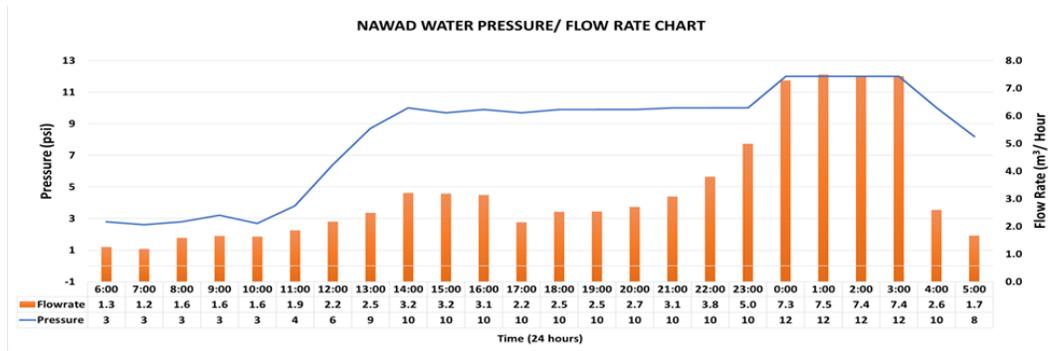
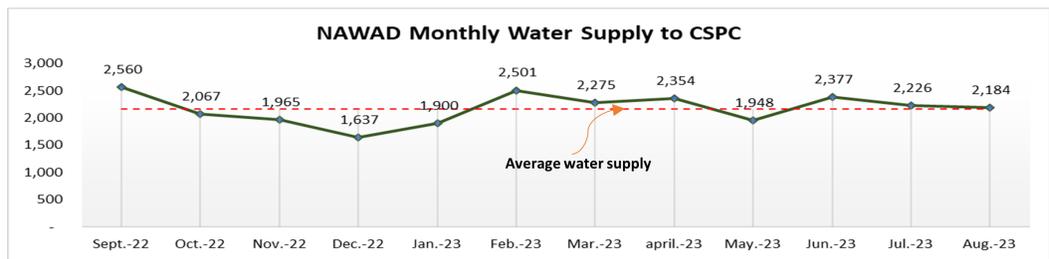


Figure 1. NAWAD Water Pressure and Flowrate Monitoring Chart

morning until afternoon is insufficient to overcome the pipe’s friction loss and the elevation head required to deliver the water inside the campus. These significantly affect the school’s water requirement, resulting in most buildings located 150 meters from the entrance not having a water supply from NAWAD. Figure 2 shows the NAWAD monthly water supply monitoring chart.



Source: Monthly NAWAD statement of account

Figure 2. NAWAD Monthly Water supply Monitoring Chart

2.1.2 Initial Data Analysis

The problems encountered in the existing system due to factors that affect NAWAD’s capacity to supply the required water pressure and flow inside the campus are best demonstrated in terms of essential quality metrics, such as efficiency, reliability, functionality, and responsiveness, summarized in Table 1.

Table 1. Problems Encountered in the Existing Water Distribution System

PERFORMANCE METRIC	PROBLEM ENCOUNTERED
Effectivity	Frequently, there is no available water in the building apart from the entrance due to inadequate water line pressure. The existing pressure control is not effective.
Reliability	Insufficient water flow rate (water flow rate from NAWAD is very low at peak time). The existing storage water level is insufficient to supply the end users' varying water demands.
Responsiveness	The main tank reservoir is too small to store water and supply sufficiently to the end-user when the water supply is needed.

2.2 Designing Stage

2.2.1 Prototype Design

This stage is essential, involving preparing a plan and carefully considering the material and devices selected for developing the prototype. The design process, guided by the information gathered from the planning stage, will create the prototype's layout and schematic diagram. The rigidity and proper placement of all devices, each playing a significant role, are essential considerations for the prototype to effectively simulate the intended system for evaluation. Figure 3 shows the orthographic views of the prototype, which show the front, left, right, and top views used to clearly illustrate the specific measurements and positions of the prototype's components.

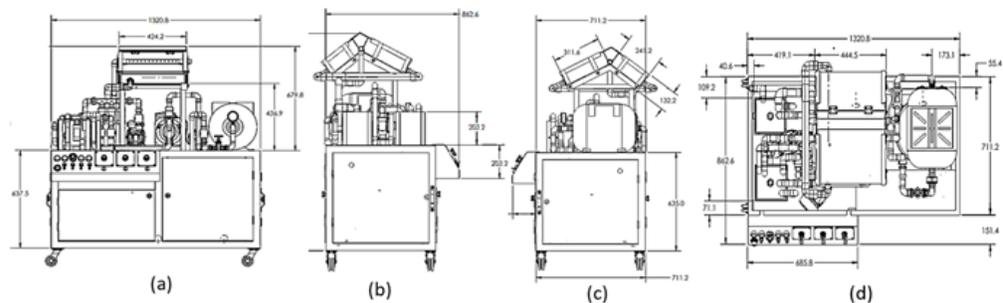


Figure 3. Orthographic views of the Prototype (a) front View (b) Left side view, (c) Right Side view (d) Top View

Figure 4 presents the prototype design, which shows the main sections and the corresponding devices used. The multi-water source automation prototype has four identified main sections: distribution section (A), rainwater source section (B), deep well water source section (C), and NAWAD water supply section (D).

Water Distribution Section (A) is the section that delivers fresh water to the end user. The distribution starts in the main reservoir tank (1), where the water is drawn by the distribution pump (2) and transferred and pressurized into the distribution tank (3) through a PVC ½ "pipe (4). A pressure transducer sensor is installed on the PVC pipe (4) and sends an analog signal to the PLC. A signal output from PLC will activate the Variable Frequency Drive (VFD) to control the motor speed and regulate the distribution tank's pressure. The Rain Water Source section (B) is the primary source of water supplying into the main reservoir tank (1); the rainwater caught by the roof (5) is transferred and stored in the rain cistern tank (6) through PVC pipe (7) until sufficient water is accumulated. The water level in the cistern tank is detected by empty-level and full-level sensors. Both are connected to PLC. When the water in the cistern tank is detected to be complete, the PLC will trigger the transfer pump (8) to deliver the rainwater into the main reservoir (1) to replace the water drawn by the distribution section.

The Deep Well Water Source Section (C), meanwhile, is the secondary source of water supplying into the main reservoir tank (1); the water drawn by the deep well pump (9) from underground

tank (10) represents the water source beneath the ground and surface water in the earth natural water cycle will transfer to the main reservoir tank (1) thru PVC ½" pipe to support if the flow rate of the rainwater is noted sufficient or replace the rainwater in it fit is not available. NAWAD Water Supply Section (D) is the supplementary water source. The water is drawn from the underground Tank (10) by the NAWAD pump (11) to the reservoir tank (1) when rainwater is not available, or the flowrate of both rainwater and deep well water source is not sufficient to replace drawn by the distribution section which supply to the end user water demand. The water level in the main reservoir tank is measured by the liquid level transducer sensor, which sends analog signals to plc to control all three water sources.

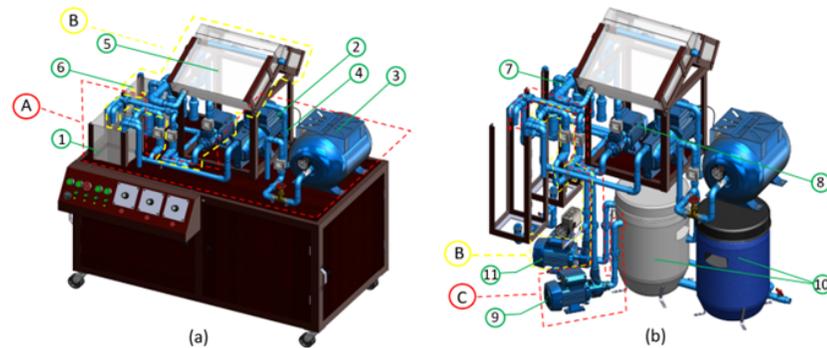


Figure 4. Trimetric view with parts label of prototype design: (a) with covered frame (b) piping system

2.2.2 Piping and Instrumentation Diagram (P&ID)

Figure 5 shows the Piping and Instrumentation Diagram (P&ID), the engineering diagram specifying and illustrating the connection between piping, process equipment, instrumentation, and control devices. The P&ID of the system describes the overall engineering processes of water control, where the inputs come from and lead, and what it needs to achieve it. The diagram puts together the assembly of the part flow. Start either at the beginning or end of the process and work through it methodically to add details of pipe, component, and instrumentation. The control signal of the instrument used is appropriately laid out in the diagram to identify quickly where the instrument is connected and what parameters are being controlled.

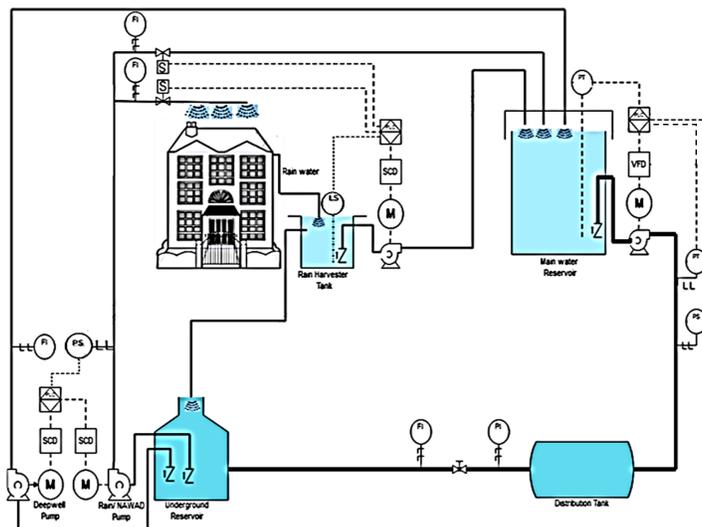


Figure 5. Piping & Instrumentation Diagram

2.2.3 Circuit Design

Figure 6 is the schematic diagram of the multi-water source automation system. The diagram uses standard symbols to describe all significant parts or tasks of a specific circuit's component. The diagram also shows which components are connected to the controller (PLC), the system's main component that controls all components functionally. The diagram clearly shows that the water level transmitter with an analog output signal of 4-20mA is connected to the PLC, which provides the real-time status of the water level inside the main water tank. PLC processes the status of the main tank to release a digital output signal to trigger which pump will operate if the water level in the main tank is insufficient. Also, it shows that an analog pressure sensor is connected directly to the PLC, which sends a signal to the Variable Frequency Drive (VFD) connected to the pump, which controls the pressure inside the distribution tank for real-time adjustment.

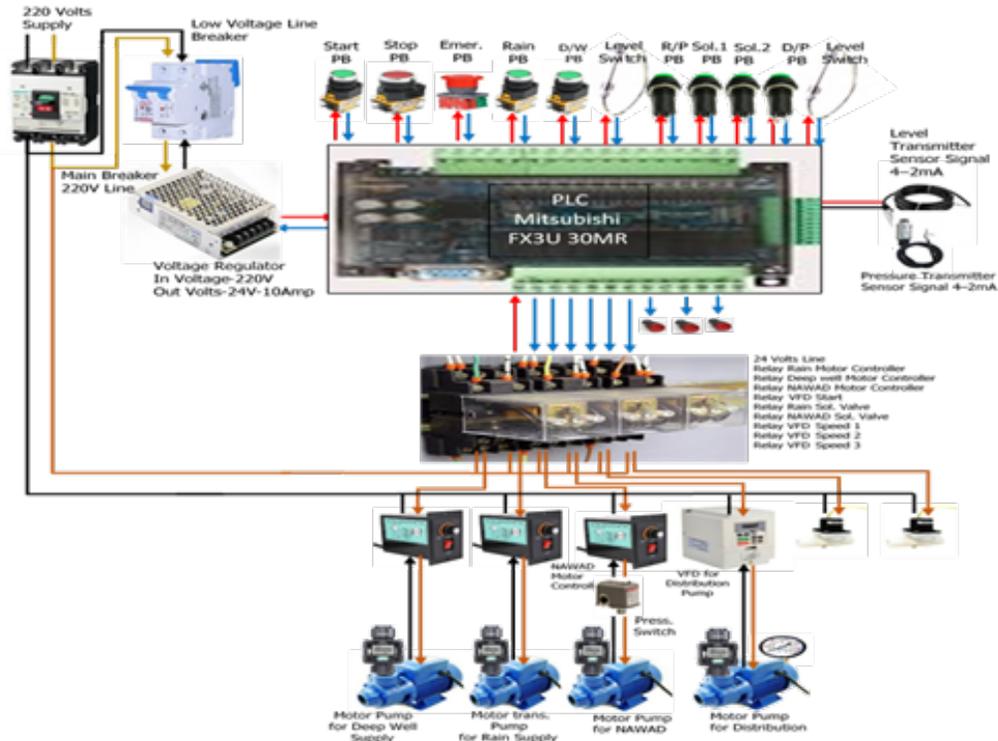


Figure 6. Piping & Instrumentation Diagram (P&ID)

2.3 Fabrication Stage

2.3.1 Prototype Fabrication

The prototype was fabricated using the design and planned procedure. The step-by-step process below was followed to ensure the prototype was built based on the desired requirements, considering its design and functionality.

- Base installation – The base was installed using the tubular metal frame. A corner support welded joint will hold it. The size of the structure is strong enough to support the weight of the devices and material positioned on its top.
- Arrangement of the equipment and devices—The positioning of the devices, sensing element, and material is an essential consideration in the success of this prototype fabrication. By placing the suitable Instrument and material based on the developed design, the functionality and the parameters needed to measure were achieved. Piping design and device arrangement are interrelated.
- Wiring – The electrical wire and switching devices, such as relays, breaker distribution

boards, controllers, and sensing devices, were connected to every other element to form the prototype. The wiring connection was based on the design layout and schematic diagram developed during the design stage.

2.3.2 Programming

In this stage, a PLC programming instruction is developed using machine language instructions or code to read input and control the devices to automatically accomplish the design action to complete the necessary process result. The programming process is demonstrated in the programming flow chart shown in Figure 7.

In this prototype, the researchers need a Mitsubishi FX3U PLC module and write the ladder program instructions using the software GX Works2, which enables the full use of high-function and high-performance CPUs.

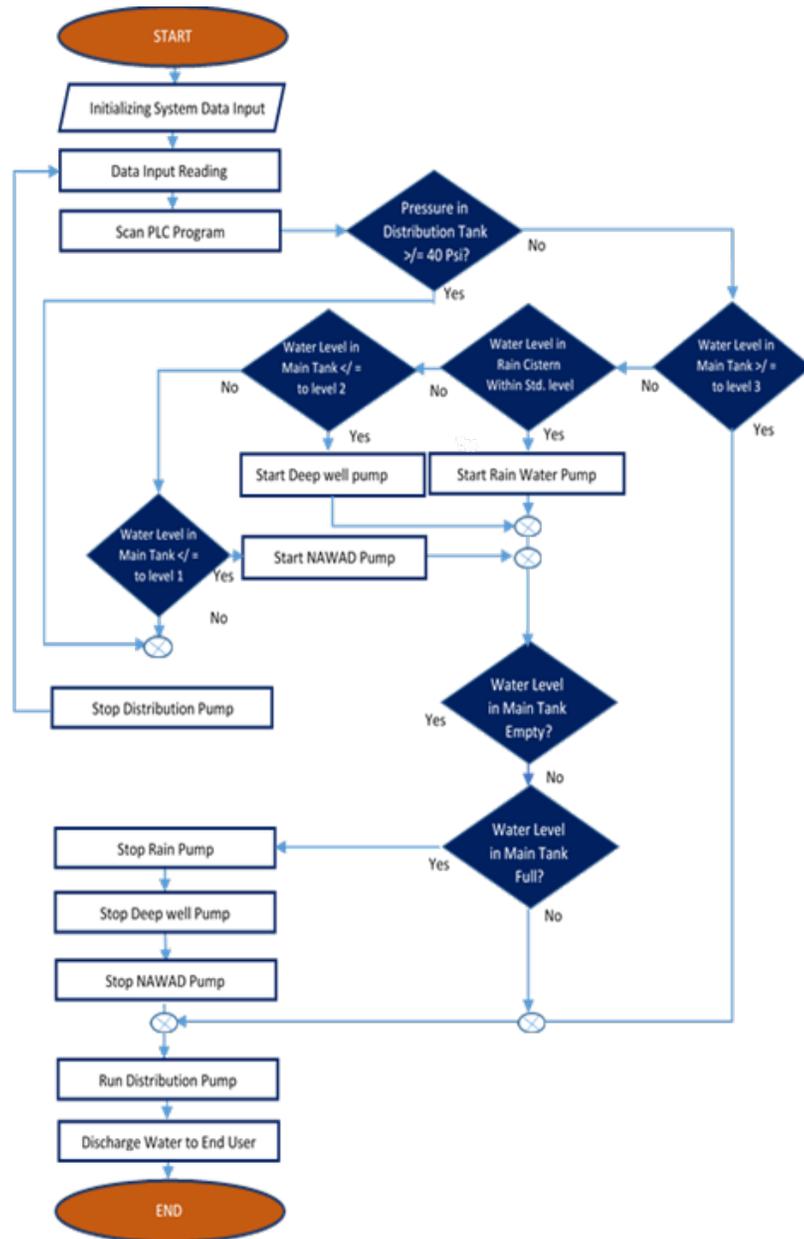


Figure 7. PLC Programming Flowchart

The ladder logic instruction is based on simple arithmetic relational operators such as the < (less than), > (greater than), <= (less than or equal), and >= (greater than or equal). It compared operators to their operands. All integral and floating-point numeric types support those operators. Tables 2 & 3 show the Logic used for pressure and water level through 4- 20mA analog Signal data. Table 2 shows a tabulated matrix containing the current prototype water pressure values based on water distribution pressure utilized inside the school campus. Likewise, Table 3 shows the water level tabulated matrix based on the prototype capacity of a 500-millimeter reservoir tank height measurement. Each cell has the resulting command corresponding to the signal from the pressure and water level sensors as input variables.

Table 2. PLC Ladder Logic Rules for Water Pressure

LADDER LOGIC INSTRUCTION	SENSOR CURRENT ANALOG VALUE (mA)	DIGITAL PLC VALUE	RELATIONAL OPERATOR	CONDITION for PLC DATA REGISTRY	RESULTING COMMAND
Speed 1	4mA	1200	=	1200	Run motor pump @ 60 hertz
Speed 2	6mA	1500	=	1500	Run motor pump @ 50 hertz
Speed 3	7mA	1600	=	1600	Run motor pump @ 40 hertz
Speed 4	8mA	1700	≥	1700	Motor stop

Table 3. PLC Ladder Logic Rules for Water Level

LADDER LOGIC INSTRUCTION	SENSOR CURRENT VALUE (mA)	DIGITAL PLC VALUE	RELATIONAL OPERATOR	CONDITION for PLC DATA REGISTRY	RESULTING COMMAND
Level 1	5	1000	≤	1000	Pump 4 = Off
Level 2	9	1300	≥	1300	Pump 1 to 3 = ON
Level 3	10	1700	≤	1700	Pump 3 = ON
Level 4	11	1900	≤	1900	Pump 2 = ON
Level 5	12	2100	≤	2100	Pump 1 = ON
Level 6	13	2300	≥	2300	Pump 1 to 3 = OFF

2.3.3 Initial Evaluation

In this stage, the prototype is pre-tested according to the Design parameters. It is an essential step to ensuring the correctness of the Multi-water sources control Automation developed by verifying functionality across different devices and program instructions, and it also determines how well the overall operation Control automation system was to ensure that the prototype operates according to its intended use.

2.3.4 Modification

Suppose a problem surfaces during the functional test. In that case, the change will require proper adjustments, and functionality was re-tested to ensure the prototype's application and performance are according to the parameters set. The final version is ready for production at the end of this stage.

2.4 Final Evaluation Stage

2.4.1 Prototype Launch

A fully functional prototype ready for use is presented at this stage. Likewise, it is used to evaluate its overall performance. The photos of the fabricated prototype are shown in Figure 8.

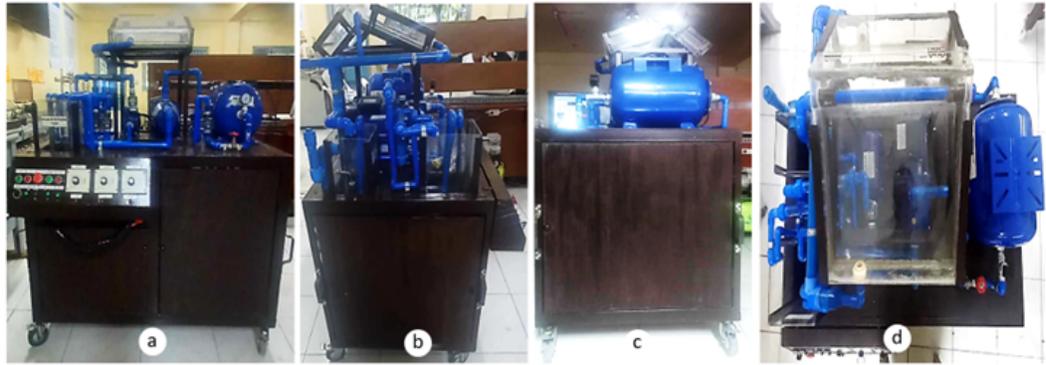


Figure 8. Photo of prototype: (a) front View (b) Left side view, (c) Right Side view (d) Top View

2.4.2 Performance Test

Performance testing is the Final evaluation of a system's performance in terms of different characteristics or parameters. In this study, the researchers will measure the performance of the multi-water source control automation based on three (3) characteristics: effectiveness, reliability, and responsiveness.

3 RESULT

3.1 Effectivity Test

The summary of data tabulated in Table 4, taken from recorded raw data, shows that the Multi-water source control automation can control within the critical limit of 26psi, which means the automated system can supply the end user at any location and on any of the highest floors of the building inside the school campus. It is noted that when the distribution pump operated at its maximum capacity (100%), is the condition the pressure falls to the critical limit of 26 psi.

Table 4. Pressure Control Effectiveness Rating

DISCHARGE FLOW	MEASURED PARAMETER	MULTI-WATER SOURCE AUTOMATION	RESULT
VALVE OPEN POSITION (25%)	PRESSURE	Minimum	36.0
		Maximum	40.0
		Range	4
	Average	39.0	
PUMP POWER	Consumed (Ave.)	Watts	529.8
	% Cap		71.0%
DISCHARGE VALVE OPEN POSITION (50%)	PRESSURE	Minimum	37.0
		Maximum	40.0
		Range	3
	Average	38.4	
PUMP POWER	Consumed (Ave.)	Watts	703.4
	% Cap		94.0%
DISCHARGE VALVE OPEN POSITION (75%)	PRESSURE	Minimum	36.0
		Maximum	37.0
		Range	1
	Average	36.3	
PUMP POWER	Consumed (Ave.)	Watts	750.3

		% Cap		101%	
DISCHARGE VALVE OPEN POSITION (100%)	PRESSURE	Minimum		26.0	Moderately Effective
		Maximum	Psi	26.0	
		Range		0.0	
		Average		26.0	
	PUMP POWER	Consumed (Ave.)	Watts	859.3	
		% Cap		115.0%	

Table 5 shows the tabulated data of the conventional system compared to that of the automated control system. The minimum pressure of the automated system has improved significantly by a maximum of 85% when the water flow rate is below the 75% capacity of the Pump. Still, once the water flow rate increases above 75%, the pump capacity shows that both conventional systems and automated systems perform the same. In terms of power consumption, at a lower water flow rate, the conventional system consumes less Energy.

Table 5. Performance between Conventional and Automated Control Systems

DISCHARGE FLOW		MEASURED PARAMETER		EXISTING SYSTEM	MULTI-WATER SOURCE AUTOMATION	RESULT
VALVE OPEN POSITION (25%)	PRESSURE	Minimum		20	36.0	Improved
		Maximum	Psi	40	40.0	
		Range		20	4	
		Average		27.5	39.0	
	PUMP POWER	Consumed (Ave.)	Watts	369.1	529.8	Regress
		% Cap		49.1%	71.0%	
DISCHARGE VALVE OPEN POSITION (50%)	PRESSURE	Minimum		20	37.0	Improved
		Maximum	Psi	40	40.0	
		Range		20	3	
		Average		20	38.4	
	PUMP POWER	Consumed (Ave.)	Watts	643.0	703.4	Regress
		% Cap		86%	94.0%	
DISCHARGE VALVE OPEN POSITION (75%)	PRESSURE	Minimum		38	36.0	No change
		Maximum	Psi	38	37.0	
		Range		0.0	1	
		Average		38	36.3	
	PUMP POWER	Consumed (Ave.)	Watts	895.6	750.3	Improved
		% Cap		120%	101%	
DISCHARGE VALVE OPEN POSITION (100%)	PRESSURE	Minimum		26	26.0	No change
		Maximum	Psi	26	26.0	
		Range		0.0	0.0	
		Average		26	26.0	
	PUMP POWER	Consumed (Ave.)	Watts	859.3	859.3	Improved
		% Cap		119%	115.0%	

3.2 Reliability Test

Reliability Testing is a test that examines the degree of consistency in the results. There is a minor difference in the result; as long as it is within the margin of error, it is still reliable.

Table 6. Water Level Reliability Rating

DISCHARGE FLOW	MEASURE PARAMETER		MULTI -WATER SOURCE CONTROL AUTOMATION				DIFFERENCE (NO RAIN VS WITH RAIN)	RESULT
	DESCRIPTION		NO RAINWATER		WITH RAINWATER			
			WATER LEVEL (MM)	% VALUE OF FULL TANK HEIGHT	WATER LEVEL (MM)	% LEVEL OF FULL TANK HEIGHT		
VALVE OPEN POSITION (25%)	WATER LEVEL	MIN	49.5	95%	49.0	94%	-1%	Very reliable
		MAX	52.0	100%	52.0	100%	0%	
		AVERAGE	50.9	98%	50.9	98%	0%	
		RANGE	3.0	-	3.0	-		
VALVE OPEN POSITION (50%)	WATER LEVEL	MIN	49.0	94%	49.0	94%	0%	Very reliable
		MAX	52.0	100%	52.0	100%	0%	
		AVERAGE	50.5	97%	49.4	95%	-2%	
		RANGE	3.0	-	3.0	-		
VALVE OPEN POSITION (75%)	WATER LEVEL	MIN	40.0	77%	42.5	82%	5%	Moderately Reliable
		MAX	52.0	100%	52.0	100%	0%	
		AVERAGE	43.6	84%	47.3	91%	7%	
		RANGE	12.0	-	10.0	-		
VALVE OPEN POSITION (100%)	WATER LEVEL	MIN	40.0	77%	40.0	77%	0%	Moderately Reliable
		MAX	51.5	99%	52.0	100%	1%	
		AVERAGE	44.5	86%	45.8	88%	3%	
		RANGE	12.0	-	12.0	-		

The data in Table 6 shows that even if one of the water sources is unavailable, and in this case, the rainwater source is unavailable, the system can still maintain a water level above 77%. It ensures that water is available at any water volume flow rate required by the end user. It is noted that at a lower volume flow rate, below the 50% pump capacity at the distribution line, the water level can be maintained at above 94% of tank capacity and falls to 77% once the water volume flow rate reaches above that 75% distribution pump capacity.

3.3 Responsiveness Testing

The responsiveness test measures a system’s capability to adjust promptly to suddenly altered conditions, such as changes in the Main Reservoir Tank, and return to the above-allowable water level without undue delay. In this study, the researchers measured the response time of the three (3) water sources connected to the main reservoir tank to measure the response time when one of the water sources is unavailable.

Table 7. Responsiveness Testing Rating

DISCHARGE FLOW	DESCRIPTION	MULTI -WATER SOURCE CONTROL AUTOMATION		RESULT
		NO RAINWATER	WITH RAINWATER	
VALVE OPEN POSITION (25%)	RESPOND TIME (SECS.)	9	9	Very Responsive
VALVE OPEN POSITION (50%)	RESPOND TIME (SECS.)	3	4	Very Responsive
VALVE OPEN POSITION (75%)	RESPOND TIME (SECS.)	3	3	Very Responsive
VALVE OPEN POSITION (100%)	RESPOND TIME (SECS.)	3	3	Very Responsive

4 DISCUSSION

The Existing Water Supplier (NAWAD) can only pump 3- 12psi of Pressure at the water supply port of entry. Thus, only 36% of the water needs of CSPC can be delivered, so there is a need to increase the water pressure to move the water to the reservoir tank inside the campus. Multi-water source automation is an appropriate solution based on the performance test results. Integrating different components, such as the sensing element, VFD, Pumps, and piping from the Supply and Distribution lines, is Compatible. The multiple water sources can dynamically respond to changes in the system. The Compatibility test conducted showed that the Water Source flowrate is always higher than the Distribution flowrate to prevent the water level in the main water tank from decreasing; the lower the flowrate in the distribution Line, the more significant the difference, and the more the motor is Idle in status to balance the water volume between the supply and the distribution line.

The effectiveness of the multi-water source automation system in stabilizing Pressure is clear. It can maintain the Pressure at or above the required level to deliver water to all locations and heights inside the campus. At 50% and below pump capacity on the distribution side, the Pressure increases significantly to 36 psi, compared to the conventional system's 20 psi (Pump Cut-on pressure). The pressure fluctuation in the automated system is within a range of 4psi. However, when the distribution pump capacity reaches 100%, the Pressure falls to 26 psi. It's important to note that this decrease in Pressure should not be attributed to the multi-water source system but rather to the limitation of the distribution pump capacity.

The resilience of the multi-water source system is a key feature. Even when one of the water sources is unavailable, the system can maintain the water level at 94% and above tank capacity when operating below 50% pump capacity. This is a significant testament to the system's reliability. However, when the water volume flow rate exceeds the 50% pump capacity on the distribution side, the water level falls to 77%. Despite this, the system's ability to maintain the water level under such challenging conditions strongly indicates its reliability. For the System Response Time, the multi-water source control automated response within 3-9 seconds, and it responded the same even when one of the rainwater sources was unavailable.

It is also essential to note that the power consumption at a lower water flow rate, the conventional system consumes less energy, as much as 44%, compared to an automated Multi-water source system. This is because the automated system uses additional power to maintain the Pressure above the critical limit. However, once the water flow rate increases, the automated system becomes more efficient, with as much as 16% energy consumption. However, this should be interpreted as something other than the automated system being more costly, since it should be noted that the conventional system can only supply up to 50% of the consumers on campus when the Pressure falls to 20psi. An additional booster pump was required to reach all the locations inside the campus, especially on the higher floors of the building. In turn, the conventional

5 CONCLUSION

The performance evaluation of the developed multi-water source automation showed significant improvement compared to the existing water distribution system. The Multi-water source Automation is highly effective in controlling the pressure within the specified control limit at any water flow rate without affecting the adequacy of demand by the end user. However, there is a need to comprehensively analyze the pressure losses in the piping if Multi-water source automation is implemented at full scale. A full-scale implementation requires two factors to select a pump: water flow rate and pressure. Piping specification and end-user water requirements are needed to adjust the multi-water source Automation parameter to the actual pressure requirement of the consumer. In addition, integrating the human-machine interface (HMI) into the system will significantly enhance the automation system's parameter adjustment adaptability. The automated system's water level control feature is highly reliable. As long as the available water sources can be pumped into the system and meet or exceed the distribution line's requirement, the system can automatically adjust dynamically within the specified level. The prototype has already incorporated an alarm for low-pressure values, low primary reservoir tank water levels, and a rainwater cistern alarm system. However, an additional alarm system to facilitate troubleshooting may enhance the system's maintainability, particularly in detecting motor problems in a multiple-motor situation. The Multi-water source automation system has demonstrated a commendable responsiveness, meeting the system's requirement within 9 seconds. This response time can be adjusted based on the end user's requirement and the dimension of the Main reservoir tank. The design of the reservoir tank plays a crucial role in the system's response. A larger reservoir tank leads to a longer system response time, reducing the frequency of motor start and stop and minimizing potential damage to the pump motor.

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