SMART WATER SYSTEM

CRISIS AIR SELANGOR

The pollution of water source lead to disruption to 1.2 million people in Selangor. How can we use water system to solve it?

GRADUATED SUCCESS

UHMT 1012
SECTION48
GROUP 4

KERANA TUHAN UNTUK MANUSIA
UNIVERSITI TEKNOLOGI MALAYSIA

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

PREPARED BY:

NG ZI XING
A21EC0213

LOO ZHI YUAN
A21EC0197

ALYA DAMIA BINTI HUZAIMY
A21EC0159

YASMEEN NATASHA BINTI HAFIZ SHAHREL
A21EC0147

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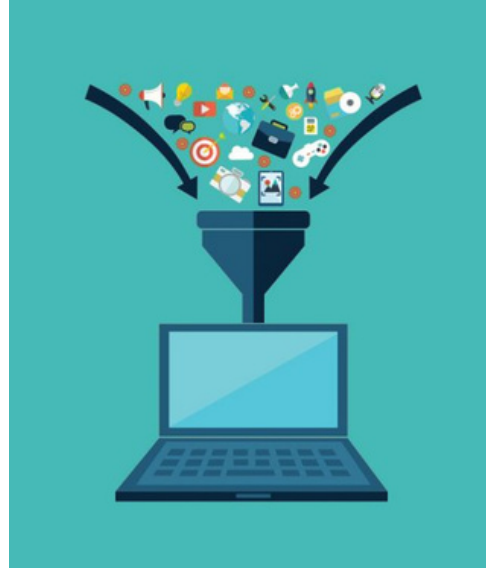
DATA
COLLECTION

We have conducted a survey about the water shortage problem in Shah Alam, Selangor for a month. The data collected based on the survey is stated below.

Most of the respondents are not Shah Alam citizens.

Are you citizen of Shah Alam, Selangor?

Yes
42.9%

No
57.1%
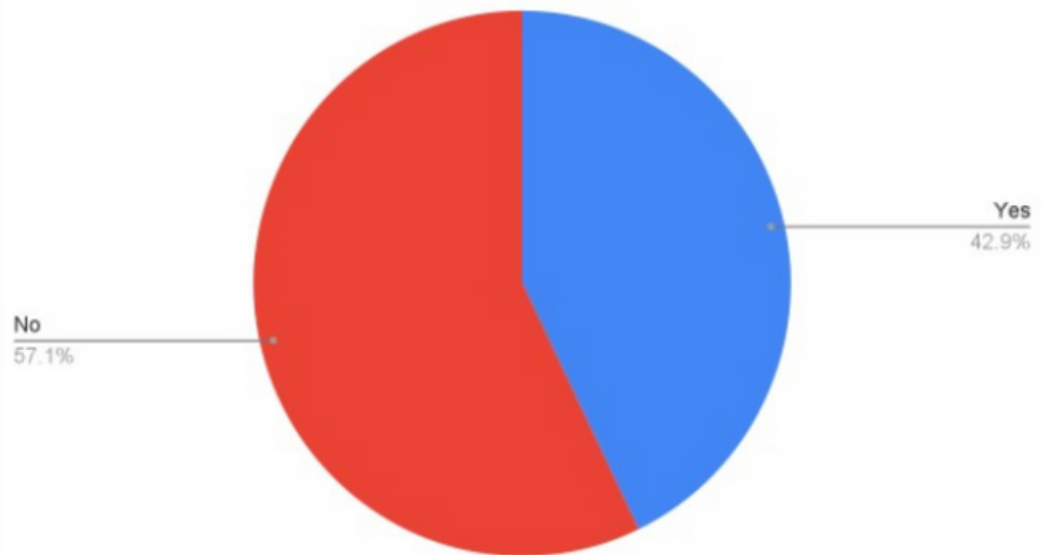
State the section that you living in Shah Alam, Selangor.

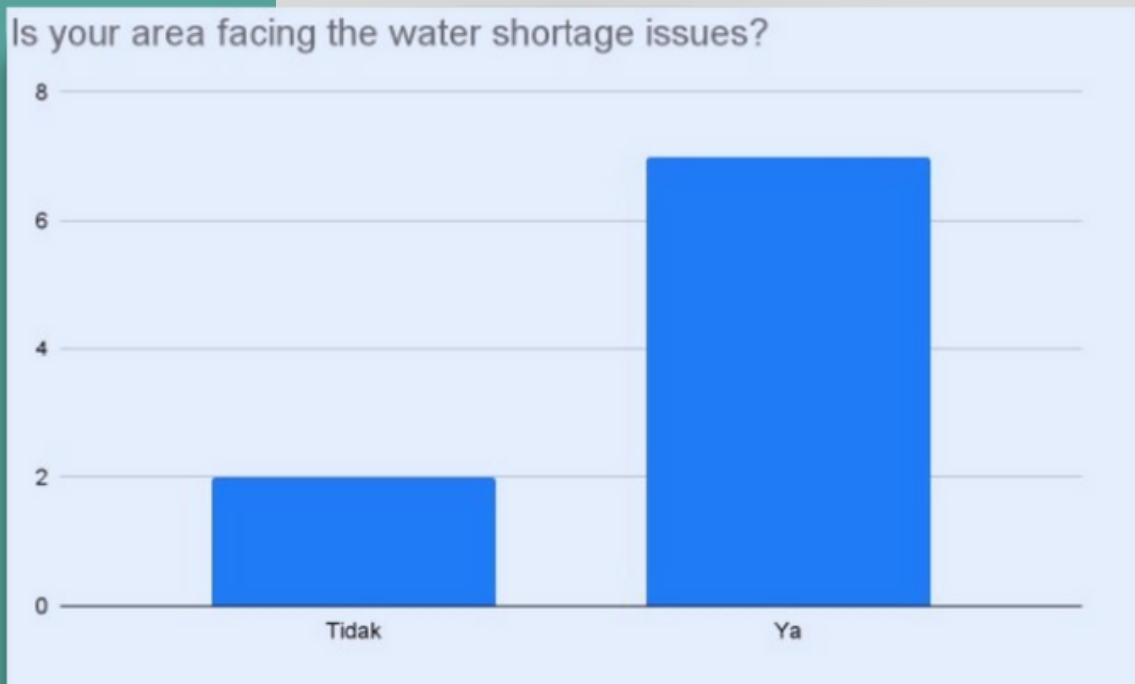Section U13 (Setia
11.1%

Other
11.1%

Section U8 (Bukit
77.8%
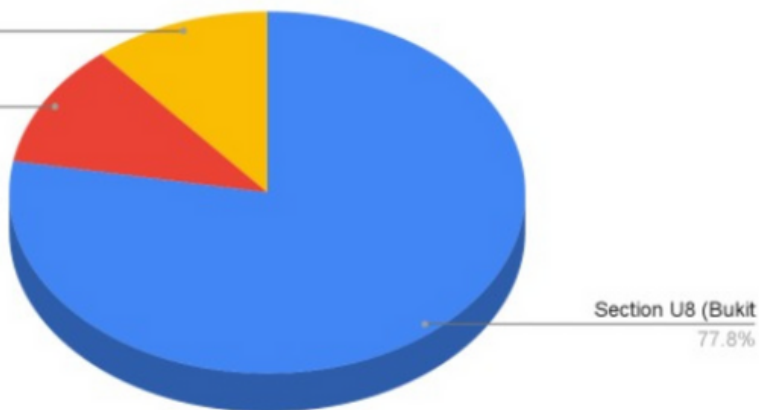
Most of the respondents that live in Shah Alam come from Section U8 (Bukit Jelutong).

SHORTAGE ISSUE

Most of the respondents are facing water shortage issues.

Is your area facing the water shortage issues?

THE FREQUENCY

How many times your place suffer from the water shortage problem every year?

2 until 5 times
22.2%

More than 5 times
22.2%

Less than 2 times
55.6%
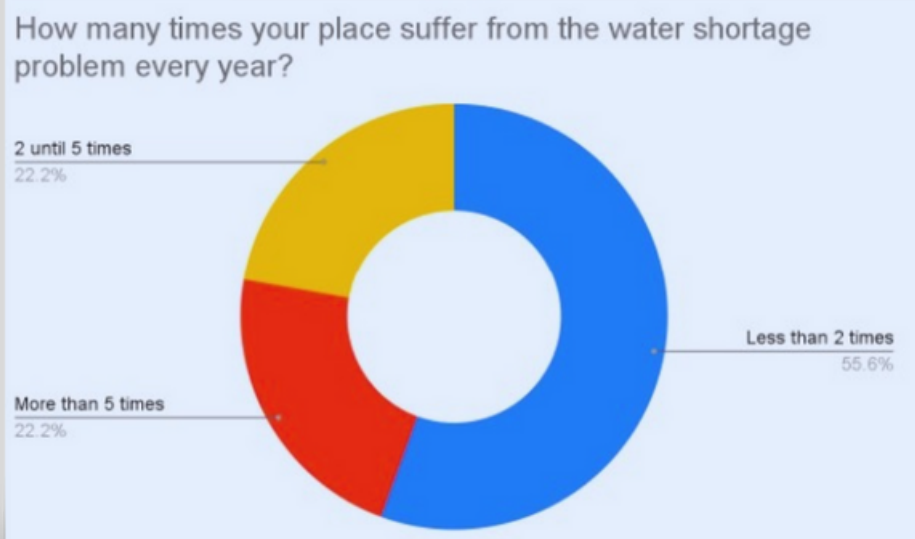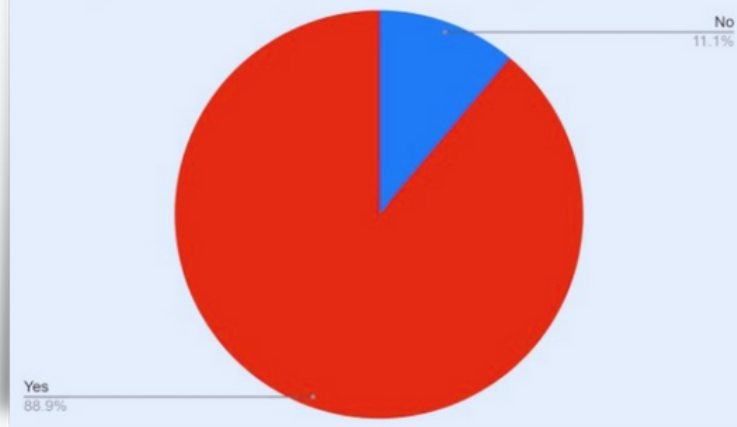

This problem happens at least once every year for the respondents.

WHO WILL HELP?

In your opinion, does the agencies mentioned above helping in solving the water shortage problem in Selangor?

No
11.1%

Yes
88.9%

Most of the respondents say that the agencies mentioned above such as Air Selangor are helping in solving the water shortage problem.

ACKNOWLEDGE?

As a non-Shah Alam citizen, do you acknowledge on the water shortage issues happening in Shah alam, Selangor?

No
25.0%

Yes
75.0%

For the non-Shah Alam citizens, most of them acknowledge this problem.

Who to contact?

Which agency and organisation will you contact while facing water shortage problem in Selangor?

LUAS
5.6%
SPAN
5.6%

SPAN, Air Selangor
11.1%

Air Selangor
33.3%

LUAS, Air Selangor
16.7%

LUAS
5.6%

LUAS, Air Selangor
22.2%
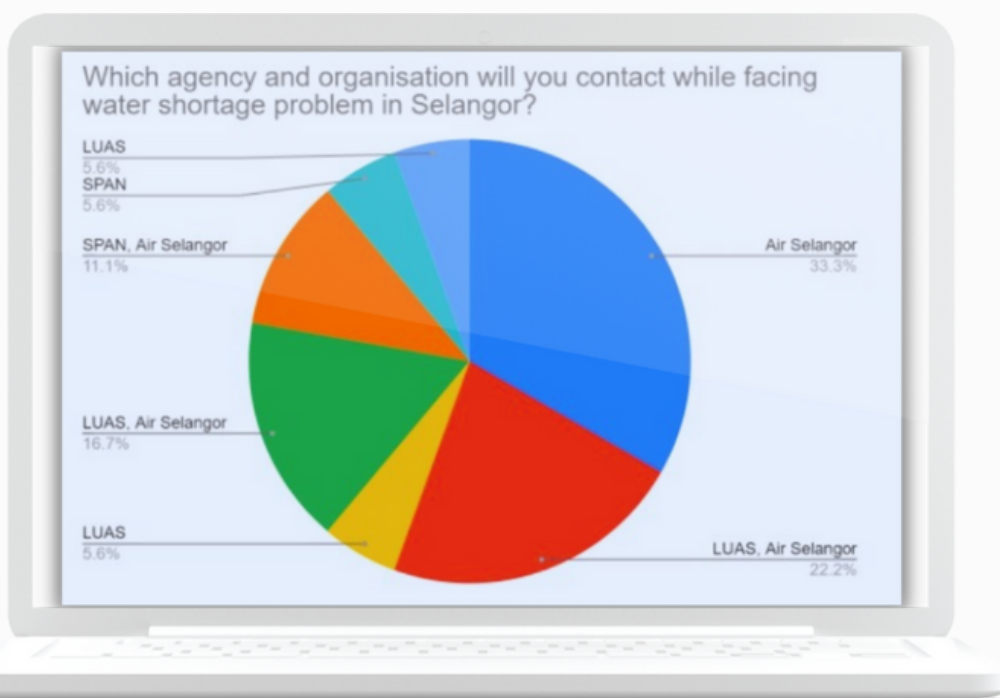
Most of the respondents will contact Air Selangor and Suruhanjaya Perkhidmatan Air Negara (SPAN) whenever the water shortage problem occurs.

WHY SMART WATER SYSTEM?

Our group had discussed and constructed a project plan on the smart water system that will make an essential impact on enhancing the water supply and monitoring system. We apply Internet of Things (IoT) devices such as smart sensors to build up the smart water system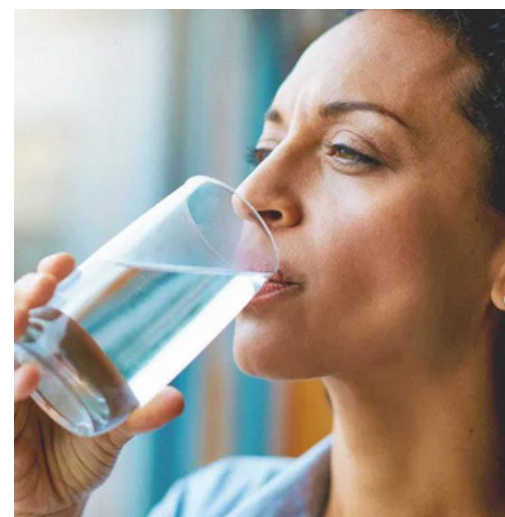. The smart water system enables us to monitor and manage the pH, temperature, Total Dissolved Solids (TDS) and turbidity values.

At the present time, water shortage is one of the biggest crises that often happens in the residential area that annoys the living of the people. Based on World Wildlife (WWF), the number of people all around the world that are facing the water shortage issue is up to 1.1 billion and a total of 2.7 billion find water scarce for at least one month of the year. This huge number is also included in Malaysia, water shortage occurs in Malaysia at least once a year in various areas such as Shah Alam, Selangor. This crisis is usually caused by the overuse of water, water pollution, bad management by enforcement bodies, illegal dumping, pipe leakage and so on.

The unpredictable occurrence of water shortage causes the daily life of the households being affected especially on the day of the spreading of COVID-19. The polluted water sources always cause the water that supply to the households becomes dirty and unavailable to use. The enforcement bodies or organizations such as Suruhanjaya Perkhidmatan Air Negara (SPAN), Syarikat Bekalan Air Selangor (SYABAS), and more that should be responsible had been working hard for few years to solve this problem but still did not manage to find out an effective way to solve it.

COLLABORATION

The collaboration with IPASA UTM is mostly for development purposes. Research, publication, consultancy, and services, as well as continuing education, postgraduate supervision, and environmental awareness development, are the core operations of the centre. IPASA UTM engineers and scientists provide environmental solutions to water and wastewater companies, water authorities, and environmental agencies by implementing cutting-edge technologies.

SPAN is a technical and economic regulatory organisation in Peninsular Malaysia that oversees water supply and sewerage services in the Federal Territories of Putrajaya and Labuan. All businesses in the water supply and sewerage services industry are regulated by the Commission, including public and private water supply and sewerage services operators, water supply and sewerage contractors, permit holders, and water and sewerage product suppliers. In terms of financing, SPAN will contribute to this effort.

SYABAS is Malaysia's largest water company, supplying clean, safe treated water to residents of Selangor, Kuala Lumpur, and Putrajaya. SYABAS will contribute to the project's development because it is their obligation to supply clean water, and they will assist us in developing the greatest technology to improve Malaysia's water system. Because the project will be primarily concentrated in Selangor, SYABAS will also be the one to fund it.

S M A R T
S E N S O R

Sensors are the main component of our system to determine the metrics of water quality. The four sensors we choose include PH, Temperature, TDS and Turbidity sensor. The IOT enables us to deploy a real time reflection system to find out the occurrence of pollution and even the source of pollution in a shorter time

PH sensor:

PH is a measure of acidity of a solution. The PH sensor could be used to track the changing of PH value of rivers over the time. The recommended range of PH of drinkable water is between 6.5~8.5. The unusual variation of PH value could reflect many possibilities of pollution. The PH value increased mostly is caused by wastewater discharge from livestock industry, domestic, market, restaurant. Because most of them will discharge ammonia which the main chemical leads to the increasing of PH caused by the decay of animal carcasses and food. Hence, the PH sensor is one of the metrics used to determine the quality of water.
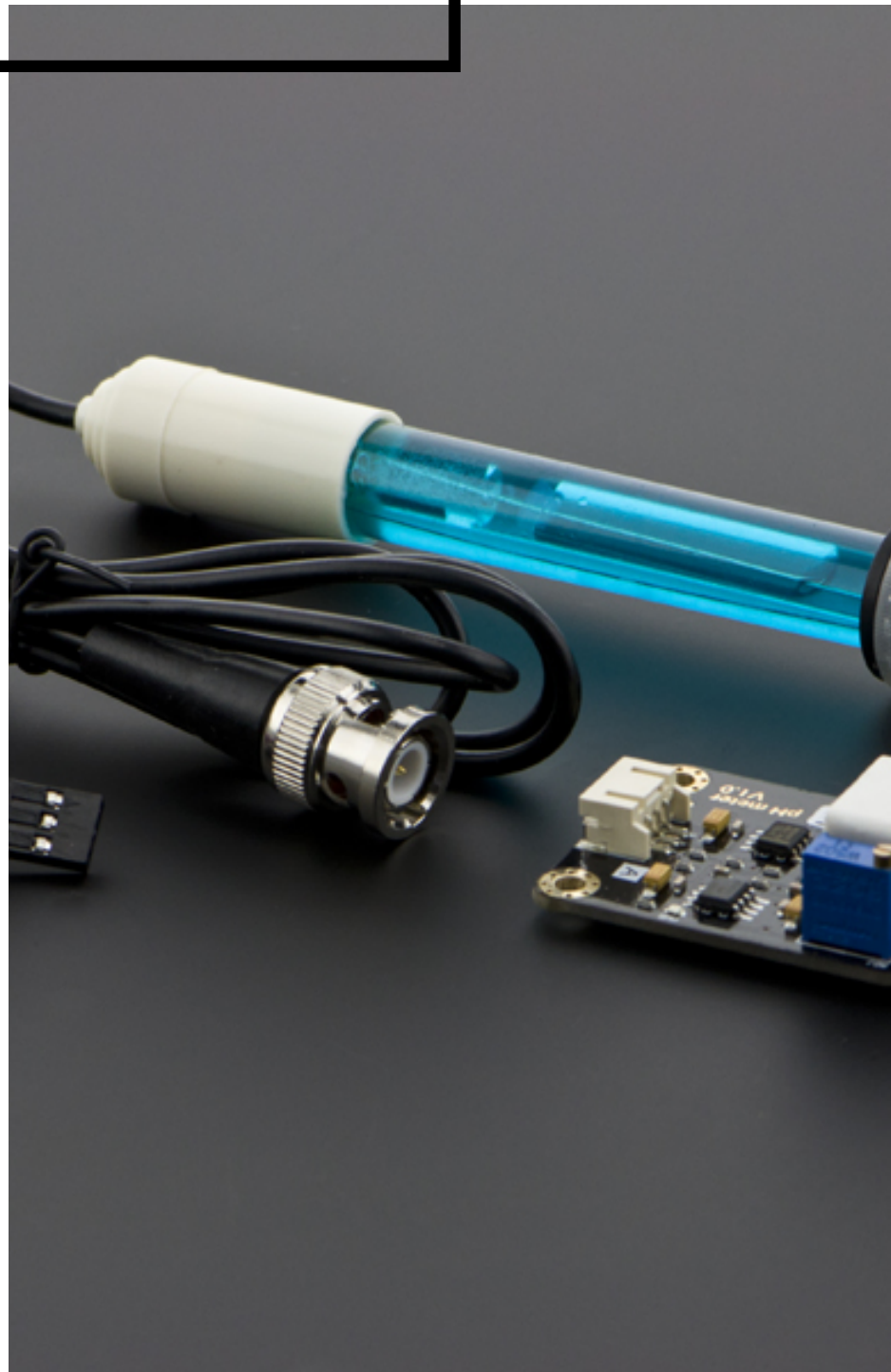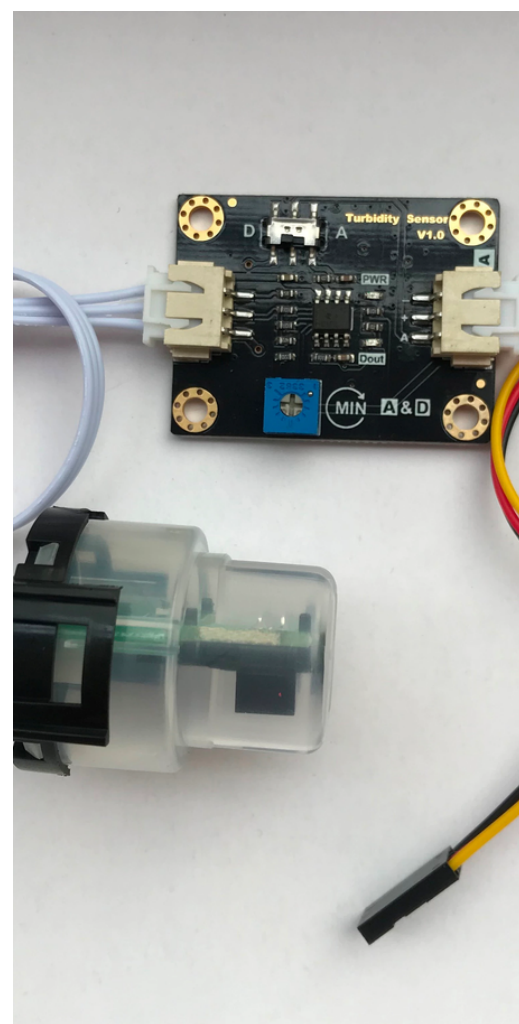
PH Sensor

TDS Sensor

Turbidity Sensor
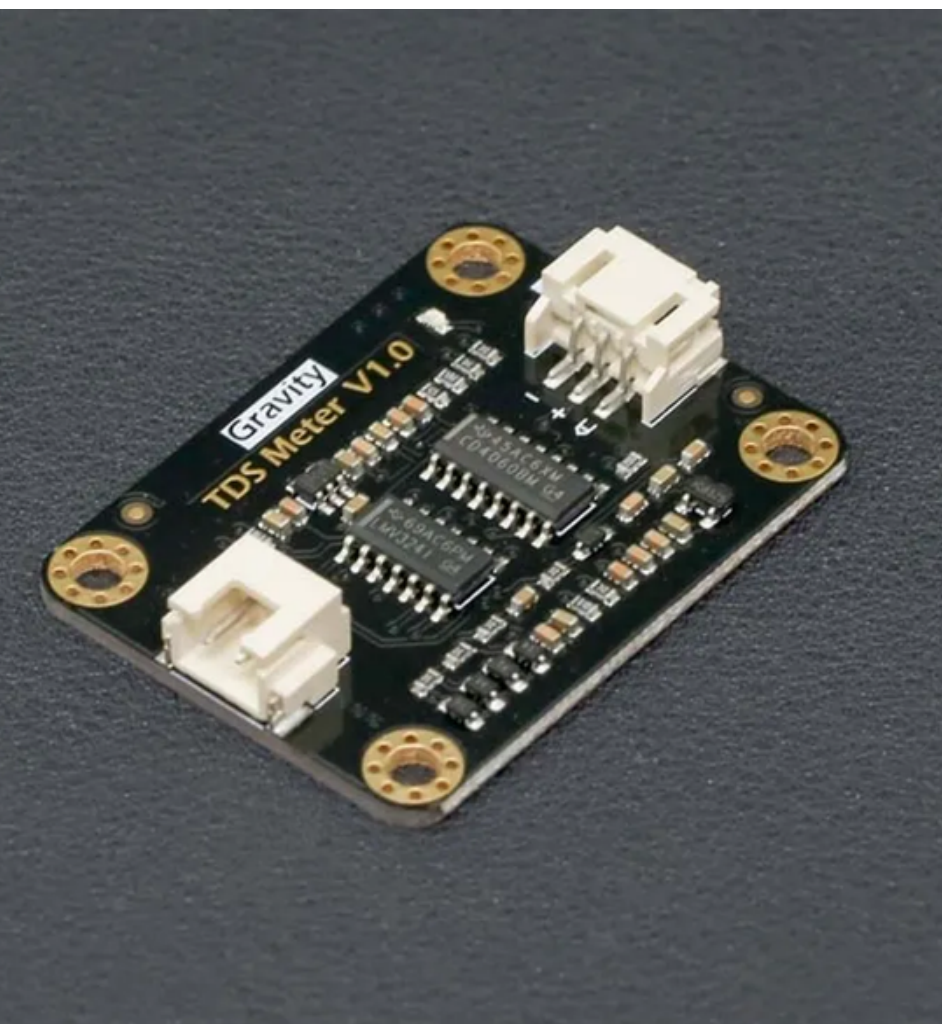
Temperature sensor:

Temperature sensor could detect the variation of temperature against the time. The temperature is highly related with Biochemical Oxygen Demand (BOD). The higher the BOD, the higher the amount of microorganism in the water. The temperature raising could accelerate the death of plants and lead to the growth of microorganisms. The high temperature water is usually exhausted by industry to cool down some machines.

TDS sensor:

TDS which stands for Total Dissolved Solids could imply directly the amount of materials dissolved in water including some harmful chemicals such as chloride, lead and sulfate. A sharp raising of TDS could remind us that someone is discharging large amounts of chemical wastewater into rivers. This kind of wastewater mostly comes from the manufacturing industry and mining industry. The TDS is an important metric to tell us the drinkability of water which is as low as possible.

Turbidity sensor:

Turbidity is the measure of water "clearness" or visibility. The higher the turbidity reflects the higher amount of suspended solids floating on the river such as plant, sand or silt. This is mostly led by improper land engineering such as residential area development and logging industry. Both of them will lead to mud flowing into the riverbed during heavy rain. The high amount of suspended solids in water will further increase the challenge and cost of sewage treatment. Thus, if we could find out the problem as soon as possible, avoiding the accumulation of the suspended substance is a key to solve the pollution.

GATEWAY MODULE

For optimal performance, we will use recently developed IoT-gateways. Simply put, IoT-gateway is a physical device or software program that will be able to serve as the connection point between the cloud and the sensors. It also serves as a wireless access portal to give IoT devices access to the Internet.

We will find ourselves faced with challenges of integrating a multitude of devices and protocols as IoT expands, with varying power and connectivity requirements. A gateway allows communication between a device-to-cloud, device-to-device, or network- to-network. These gateways will be able to perform various functions such as protocol translation, device connectivity, security, updating, management, and data filtering and processing. There are also other advantages of using an IoT-gateway.

First of all, as IoT-gateway is an intelligent device, it will be able to only send the necessary filtered data to the cloud, thus improving communication and response times. Although our sensors can still work without this IoT-gateway, it will be a hassle.

Secondly, security risks will increase as our devices expand. Fortunately, an IoT-gateway can provide another layer between the internet and the device itself. It will also enable further investment in the future while providing extra security for the devices that we already own.

Other than that, IoT gateways are an example of "intelligent edge". This simply refers to edge devices that collect, communicate, generate, and analyze data in near real-time. Data can be processed and understood by the IoT gateway itself, without having to require a third party or humans to process the information.

In a nutshell, it is necessary for us to use an IoT-gateway as it helps to bridge the gap between operations and IT infrastructure. Therefore, IoT-gateways can help us send the data from our sensors to the cloud. Even though it may be costly, for strong security and optimal performance, developers are encouraged to use recently developed IoT-gateways.

CLOUD SERVICES MODULE

We will use the Azure SQL database to store our data. This cloud is an on-demand cloud solution that offers all the constantly updated infrastructure and resources required. It provides a flexible and efficient model to deliver services and infrastructure required to empower IoT-enabled devices and applications. We will be able to create a high-performance data storage layer for our data.

One of the main reasons why we choose Azure SQL database is because it is a fully managed platform as a service (PaaS) database engine that handles most of the database management functions such as upgrading, patching, backups, and monitoring without user involvement. There are also many other advantages of platform as a service (PaaS) database engine. Firstly, it is cost effective. There is no need for us small organizations to purchase hardware or pay expenses during downtime. Secondly, it also allows us to focus only on what we specialize in, without having to worry about maintaining basic infrastructure. Not only that, it also saves time as there is no need to spend time setting up the basic infrastructure. In terms of security, PaaS invests heavily on security technology.

Many cloud services have already been available in the market. By using these platforms, developers can easily store, visualize, and analyze sensor data. It provides flexibility as we can access cloud services from anywhere with an internet connection. In addition, IoT related things could also be accessed and managed more easily. Cloud servers are capable of predicting future trends in water quality and can inform end users.

As for the pricing of our cloud services, Azure SQL Database by Microsoft offers a pricing range starting from $530 per month and increasing based on our user's needs. The pricing is more affordable compared to other database services providers such as AWS RDB by Amazon. Therefore, it helps to reduce the budget allocation of the project plan with its reasonable pricing.

USER INTERFACE

(DATA ANALYSIS AND VISUALIZATION)

This part focuses on data visualization, water quality judgment and water quality prediction. The data visualization could help us to see the data be presented in a graph to see the trend. The water quality judgment utilizes machine learning to determine the level of pollution based on data instead of human intuition. The water quality prediction is important to predict the future change of the water quality.

We provide an interface to visualize the data collected. The data could be graphed in 2d with one metric against another metric over the time. The metric against metric graphs could be used to expose the relationship between metrics. If the metrics are growing together, pollution may have the properties of raising these two metrics and in turn diminish the scope of searching for the source of pollution. Besides, when we observe the data over time, we could see how the trend would be in the future, such as when PH is growing over the time, we could raise our attention and have enough time to find the reason instead of waiting until the situation becomes serious and have to stop the sewage treatment center.

The judgment of water quality most of the time is ambiguous except in some extreme situation. Based on research, the author recommends using the K-means clustering algorithm to cluster the water quality into some groups which represent different quality based on the metrics. If a new data is classified into a low quality group, then the new data has high likelihood to be a low quality water.

For prediction of water quality, due to the water quality changing over the time which means the quality is represented as sequential data. Thus Recurrent Neural Network which is a robust model nowadays can predict sequential targets and fix this problem. If the metrics are highly escaped from our prediction, we could consider early whether our water quality is being polluted.

RIVER KLANG

COST ESTIMATION

To determine how much cost to implement this project, we have to decide which river is in plan and how fast the water flow. If the choice is Klang river(river in Shah Alam), the length of the river is around 120km, width varies from 50~300m so we take the average 150m, depth of river mouth is around 1.945m and the average water flow rate is 50m^3/s. By this, we could estimate the speed of the water stream is around 0.171m/s. To build a real-time responding system, the space between sensors is important. If assuming the sensor will detect the pollution discharge at most 6hours, by the speed of the river stream, we can know the interval should be 3.7km.

The price of each type of sensor around:
- PH sensor RM300
- Temperature sensor RM 100
- TDS sensor RM70
- Turbidity sensor RM68

If assuming at an interval of 308m, there are four of each type of sensor installed, the price is RM 2152. By the river length of 120km and interval of 308m, we can estimate the cost require is around RM 70,000. Besides, the average salary of a data and software engineer is roughly RM4000. If inviting 3 people of each engineer and work in 3 months, the cost in the human source is RM 24000. In conclusion, we could estimate the initial cost of this project is roughly RM 94000.

SAFETY MEASURES

ANIMALS

To prevent our system from being destroyed by animals, we will install fences surrounding our smart water system. The system will also be camouflaged to disguise its presence from animals.

WATER SPEED

To prevent the water system from being damaged by water speed issues, we will measure the deep of the system carefully before the installation. Furthermore, we will ensure that our water system will always be nailed to the riverbank. Other than that, the surface of the sensors used also will be as tiny as possible.

WATER CORROSION

To prevent the water system from being damaged by water speed issues, we will measure the deep of the system carefully before the installation. Furthermore, we will ensure that our water system will always be nailed to the riverbank. Other than that, the surface of the sensors used also will be as tiny as possible.

SMART CITY

How does smart water system contribute to smart city?
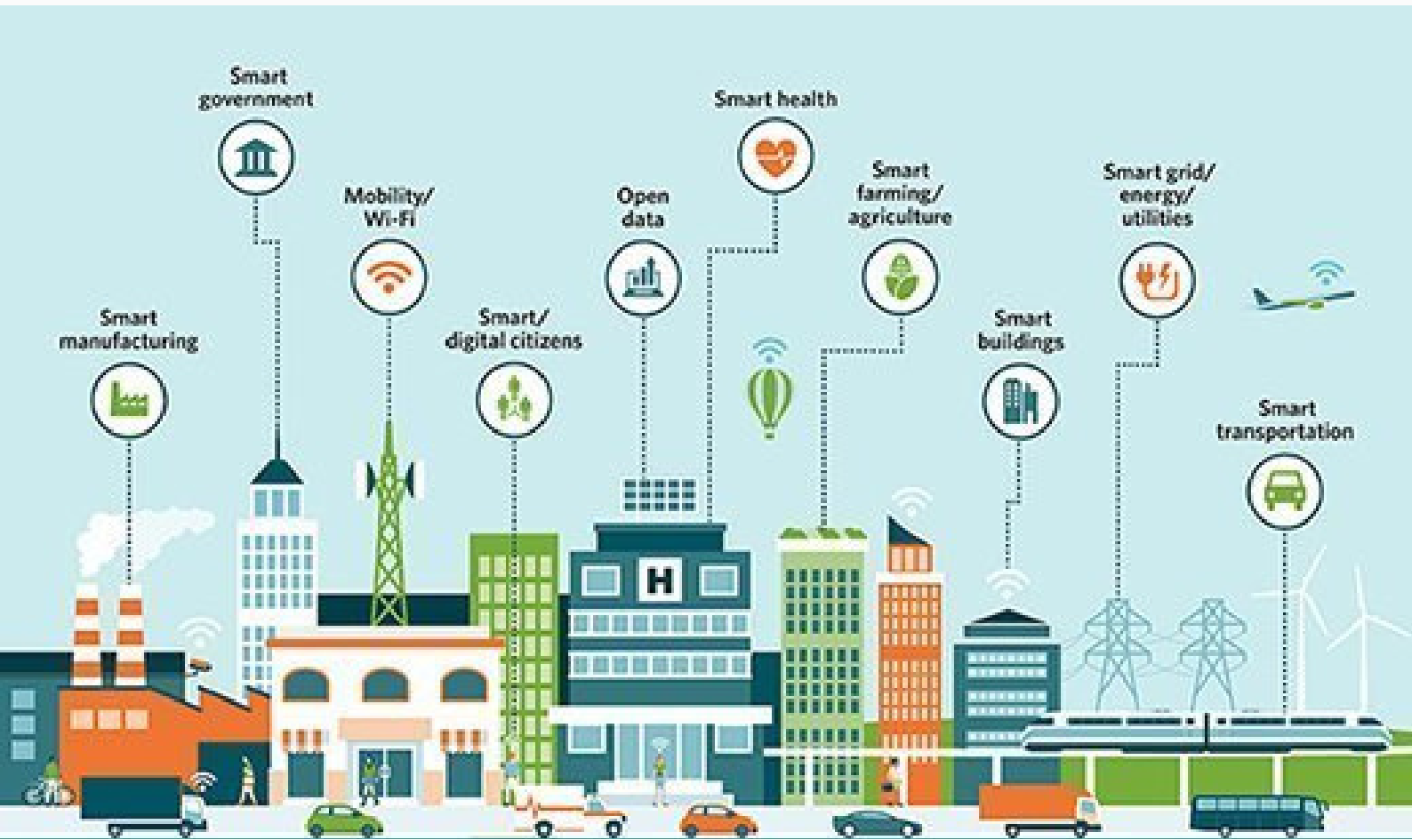
One of the most essential and urgent smart city discussions is water management. Water access is intimately linked to our quality of life and has become increasingly important in our fight against the coronavirus, as seen by the widespread use of water for handwashing and cleaning public areas and houses.

The demand for water has risen dramatically. This raised the question of how we might better manage this limited resource to guarantee that everyone has enough. Smart water refers to water and wastewater infrastructure that efficiently manages this valuable resource, as well as the energy necessary to convey it.

Digitalisation has the potential to make water management more proactive and predictive, ensuring that we are continually monitoring the state of our water systems, responding to any changes in real time, and resolving any problems before they arise.

For example, water loss due to leakage, often known as non-revenue water, is a major concern for many cities' water management.
Water utilities can employ digitalization to implement technology that control water flow based on demand via remote sensors.

This lowers any surplus water pressure, limiting water leaks and losses while saving money and energy. In addition, a smart city approach to water management ensures that one of a city's most vital infrastructure systems runs more reliably and robustly than older systems.

Water networks may obtain information that allows them to operate in a more predictive manner, minimising downtime and avoiding major commercial and environmental consequences, thanks to the Internet of Things, enhanced real-time data collecting, and sensors.

To empower our cities, we have technology at our fingertips. The first step is to adopt an integrated operations strategy. Streamlining the city's water operations and processes, for example, allows us to thoroughly monitor and analyse data collected from various touchpoints in the water system, giving us a clearer picture of the city's water management for improved analysis and forecast.

Second, we must increase investment in research and development so that new information and technologies may be tested on a regular basis and fed into the upgrading of a city's smart operations.

Malaysia's government has made enormous investments to promote its goal of modernising the country through digitalization.

People are another important factor. The next generation of smart city leaders must be prepared. To shape the future generation of urban planners, engineers, architects, and other professionals, we must look to educational institutions.

Finally, partnership between the public and commercial sectors can help smart cities evolve faster. Governments have the ability to affect change, whereas corporations are motivated by a desire to be a part of the solution and can provide personal knowledge of what governments need to do to unlock private-sector investment.

The pandemic has provided us with an opportunity to focus our attention on what needs to change, re-evaluating how cities are designed, maintained, and lived in, and ensuring that our limited public resources are directed to the most pressing needs. Whether we like it or not, our cities are about to change. We should be prepared for the next test.

CONCLUSION

Our original intention was to create a system that makes the synchronized and live data accessible to the public and convenient. Hence, the public can act as a watcher other than the enforcement and organization itself. Besides that, the related enforcement and organization will also have more detailed data on the water system because of the IoT technology that we applied in the smart water system.

The cloud services module, Azure SQL Database, which serves as a platform as a service (PaaS), allows us to analyze the water system every month or even daily. This helps the management notice abnormal details, and quick response and action toward the problems can be made.
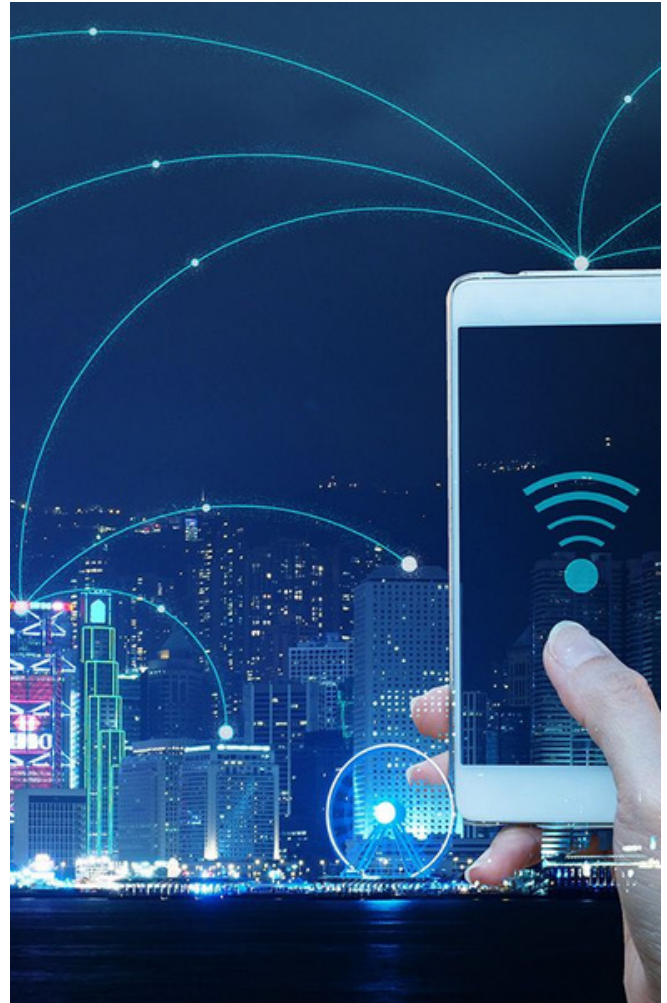
In conclusion, the smart water system will play an essential role in the future to make sure the water shortage problem can be reduced and completely disappear from our life. We also know that to make sure that the smart water system can be realized, it needs long term and complete planning that considers various factors and issues. Therefore, we are encouraging the enforcement bodies and other organizations to work hard with this project to benefit all of us.

GS ASSIGNMENT
BY GROUP 4
- NG ZI XING
- LOO ZHI YUAN
- YASMEEN NATASHA
- ALYA DAMIA

Faculty of Engineering,
Universiti Teknologi Malaysia,
UTM Skudai, 81310 Johor,
Malaysia.

UTM-MY-CH01CE