WATER METRIC STEPS

TIMELINE

WHO ARE WE?

PROBLEM DEFINITION

Our Idea

Project Objectives

Arduino Part

Data Science Part

Website Part

Future work

Conclusion

WHO ARE WE?

Students of Computer Information Systems

ANAS ALQADY

DUAA ALSAAIDEH

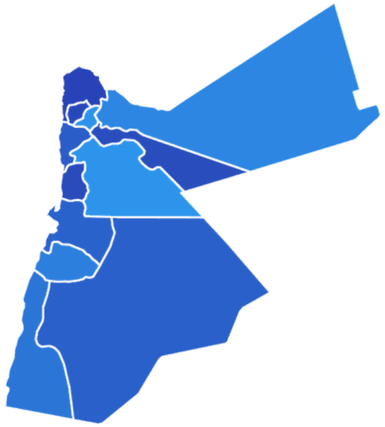
YOUSEF HABBEH

وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ

القرآن الكريم

"WE MADE FROM WATER
EVERY LIVING THING"

QURAN KAREEM



Jordan is considered one of the **10** poorest countries in water.

Water poverty line

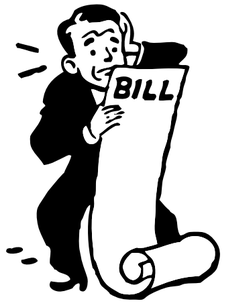
Per capita less than **88%**

More than **75**% wanted to use a smart water watch.

PROBLEM DEFINITION

Water scarcity

Late detection in bill value



No alerts about bill value

THE SOLUTION

A **smart water watch** connected to a **website** where the user can access at any time to know **3** main things:

1

The value of water consumption per square meter synchronously.

2 **The expected value of the water consumption during each cycle in proportion to the water consumption synchronously.**

3

The value of water consumption in JD synchronously.

Our Aim

01

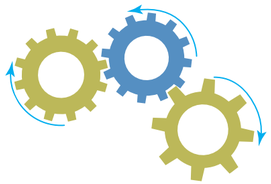
Understanding

understand current household water use behavior and water use patterns in Jordan city.

02

Improving

improve the efficiency of household water use.



03

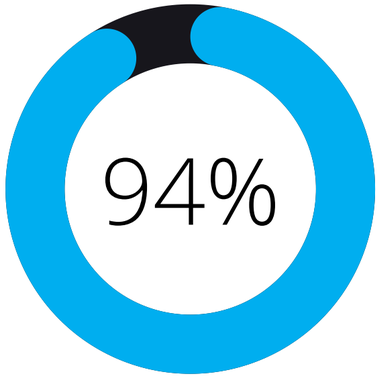
Encouraging

encourage sustainable use and conservation of water resources.

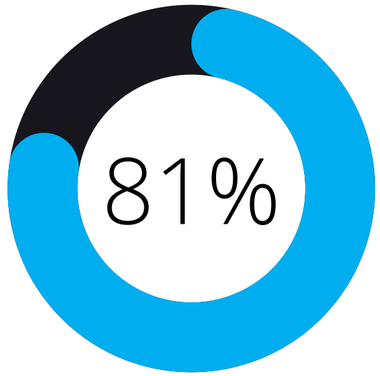
04

Rationalizing

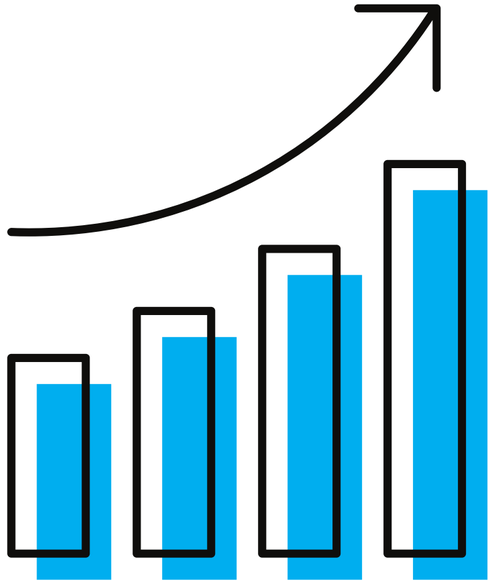
rationalize Water consumption.

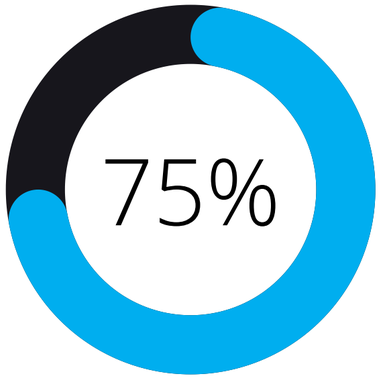


of people wanted to use a smart water meter if this will help them to decrease water consumption by 30% or more.



of people would like to buy it if it was a product offered for money.





of people were having problems knowing the value of water consumption.

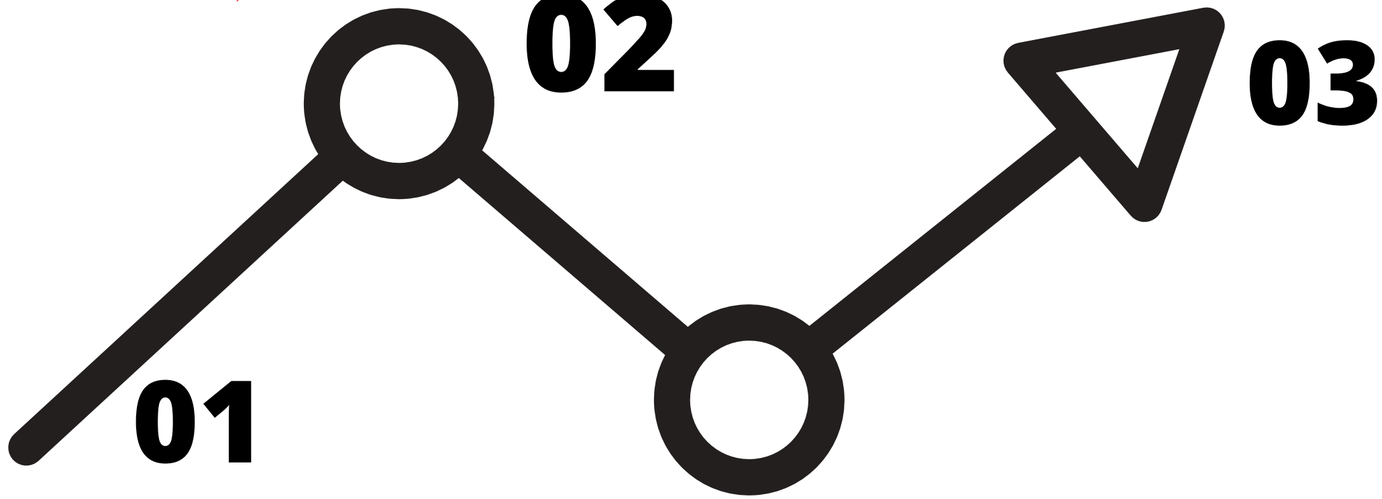
Main parts of the project

Duaa

Data science and building a predictive model for the project

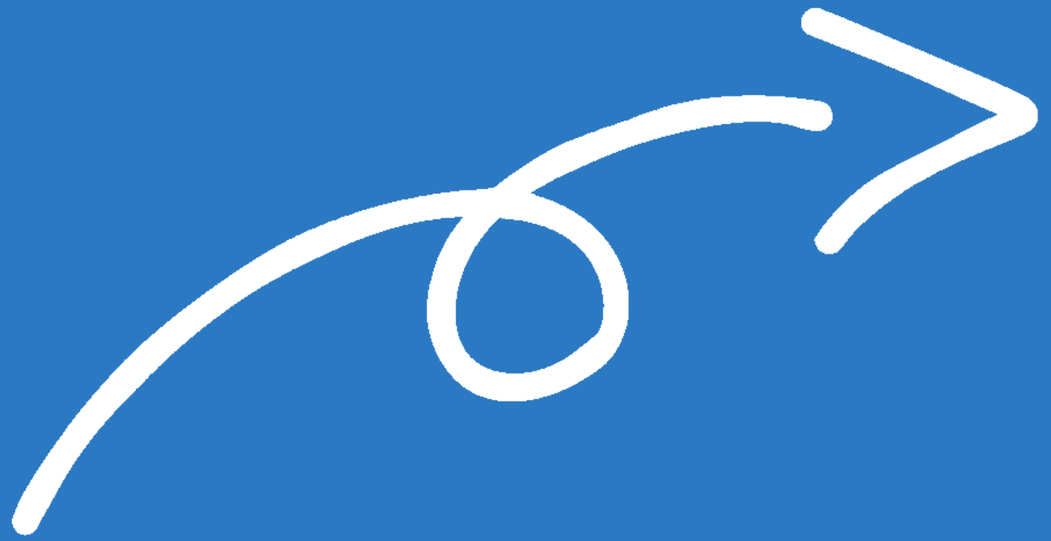
Anas

Website, user interface and data display after processing



Yousef

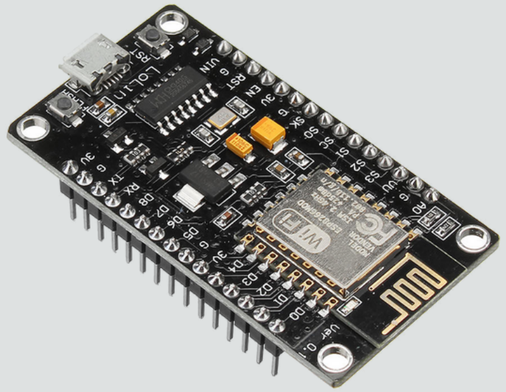
Arduino program and water clock and its components and how do they work?



Arduino Part

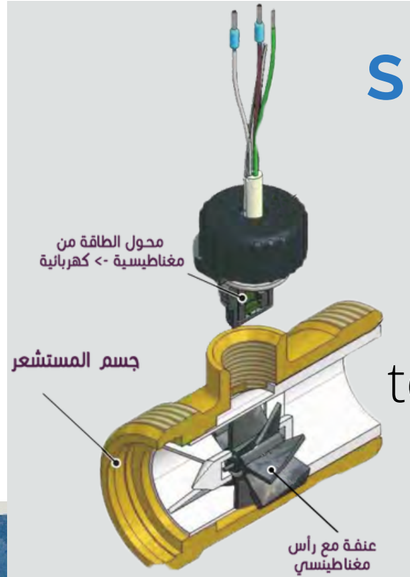
FLOW METER

Micro controller



Controllers are computer devices that allow us to create commands and control system devices as required.

SENSOR

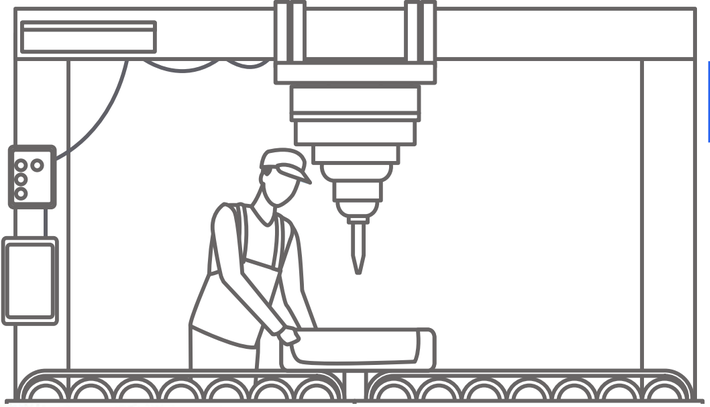


It works according to the pulses principle.

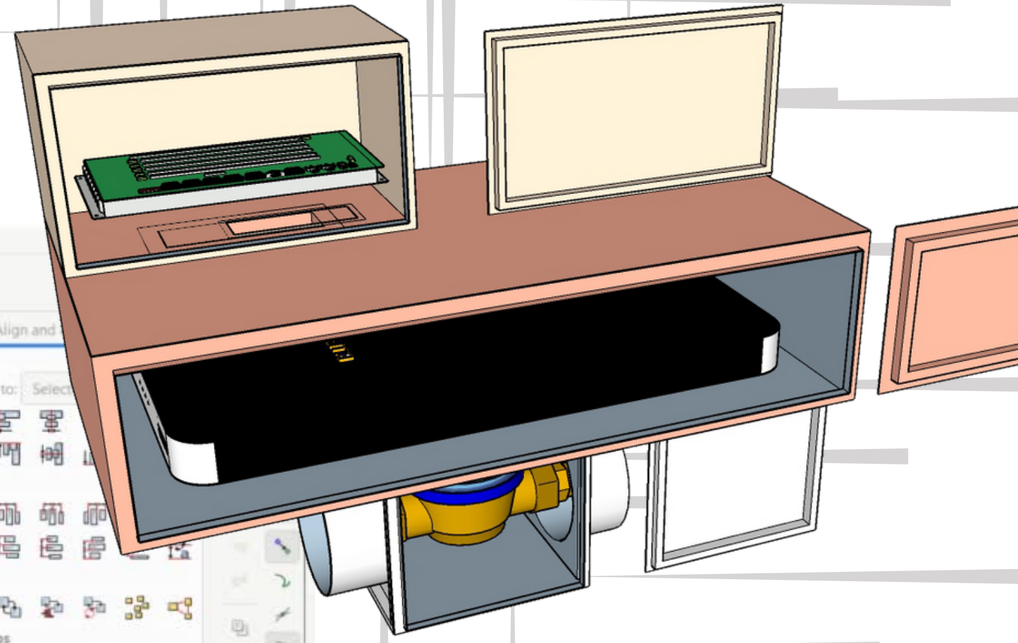
With each rotation of the turbine the resistance changes in the transducer, sending pulses to the controller.

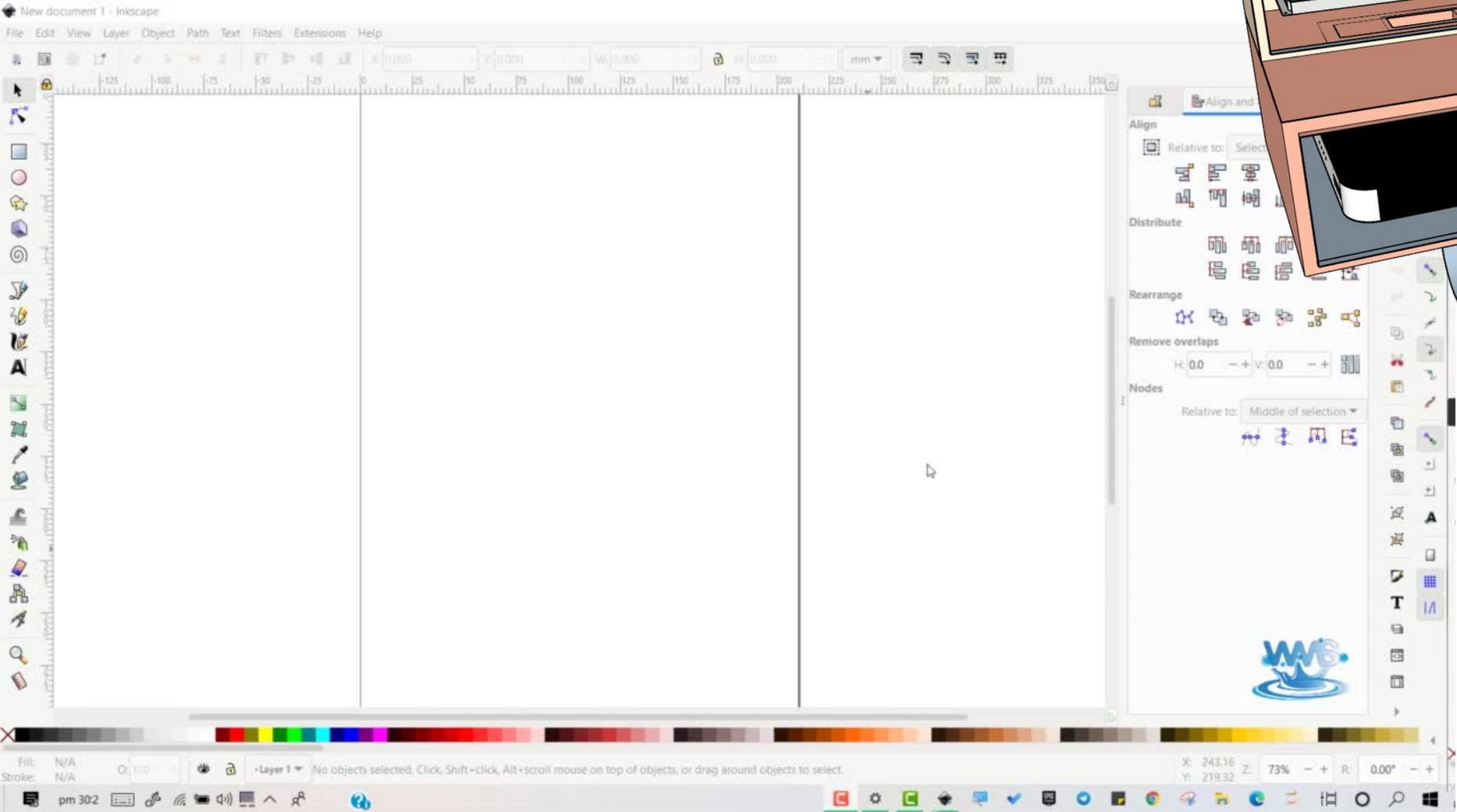
Energy

Controllers and sensors require power to send and receive data, so a portable rechargeable power supply was used.



MANUFACTURING STAGE





GENERATED DATA

Why did we generate Data?

Since we need a lot of time to collect data from users, and we do not have it, we decided to generate data that will be the base of the prediction algorithms.

100,000 records were generated for 10,000 families.

The data's components and how it was done.

User ID	ID national	full name	family member	seasons	weekly	monthly	Quarterly
11666	9873698843	منير محمد سليمان حميد	8	Spring	7.11	33.14	83.61
75296	9456605169	هبة عبد السلام مجدلاوية علان	2	Summer	2.07	8.05	25.89
20350	9451799815	سامر عبدالغني مرزوق بدايرِ	4	Summer	4.70	15.89	55.92
94396	9582029028	حنين عبد الحميد مجدي البسطامي	8	Winter	4.13	14.74	44.70
19178	9507702961	ايه محمد مرجان عقيل	9	Spring	8.63	30.77	102.08
71573	9773012954	ملك مخلوف حسين الفرج	8	Autumn	5.29	22.91	72.04
48541	9803107428	عبد الرحمن محسن محمود العزه	6	Winter	2.56	11.23	38.85
67042	9831238257	رؤى محمود أسامة عربيات	8	Winter	3.96	16.25	53.99
95723	9683463637	همسه عبد الله عبدالفتاح جدو	6	Spring	5.91	25.85	68.53
77335	9802575548	فارس عبد الخالق يعرب لوباني	4	Spring	3.60	16.76	43.32
73799	9593543052	ماريدا عبد السلام محاسنة ابو طوق	8	Spring	8.07	28.66	96.88

GENERATED DATA

PERSONAL INFORMATION:

1 - THE DEVICE IDENTIFIER:

Consists of 5 numbers a random function was used and called recursively.

2- THE NATIONAL NUMBER OF THE BREADWINNER:

Numbers were formed starting from 9411 to 9972, which means who was born from 1941 to 1997, with ages ranging from 24 to 80 years old.

3- FULL NAME:

A file containing approximately 1000 quadruple names was used, where the names were separated and re-grouped randomly, and with this, we obtained 10,000 different quadrant names.

GENERATED DATA

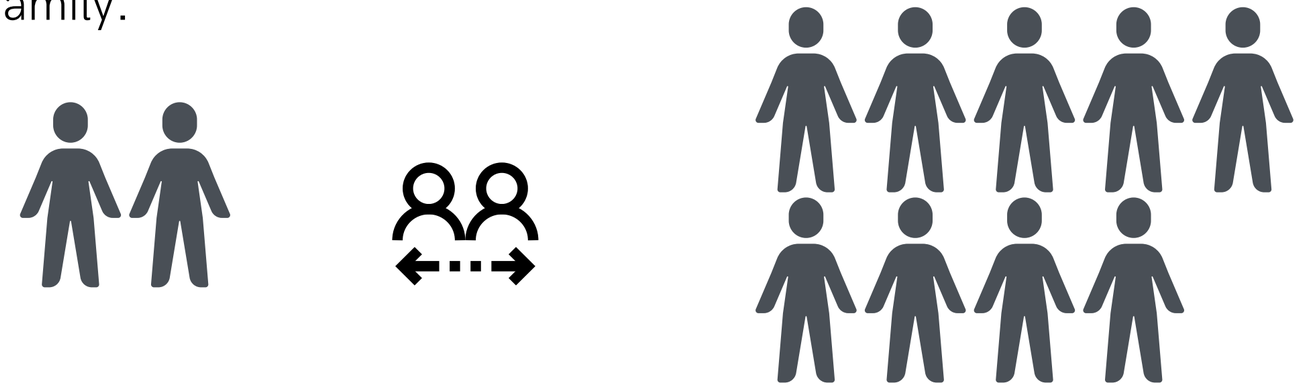
THE Affecting factors:

1- RATE OF INDIVIDUAL CONSUMPTION

The factor was according to the consumption rates of individuals in Jordan, ranging from 90 to 120 liters/day per person.

2- NUMBER OF FAMILY MEMBERS

A variable with a random number of members per family was created, where the range was from 2 to 9 individuals per family.



GENERATED DATA

3- Seasons change:

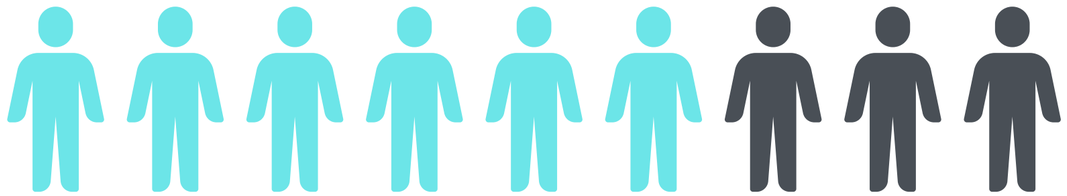
We have created a random value that bears one of the four seasons for each family the range of the impact was from 0.6 to 1.4 per capita consumption according to the season so that the distribution of the impact of the seasons was as follows:

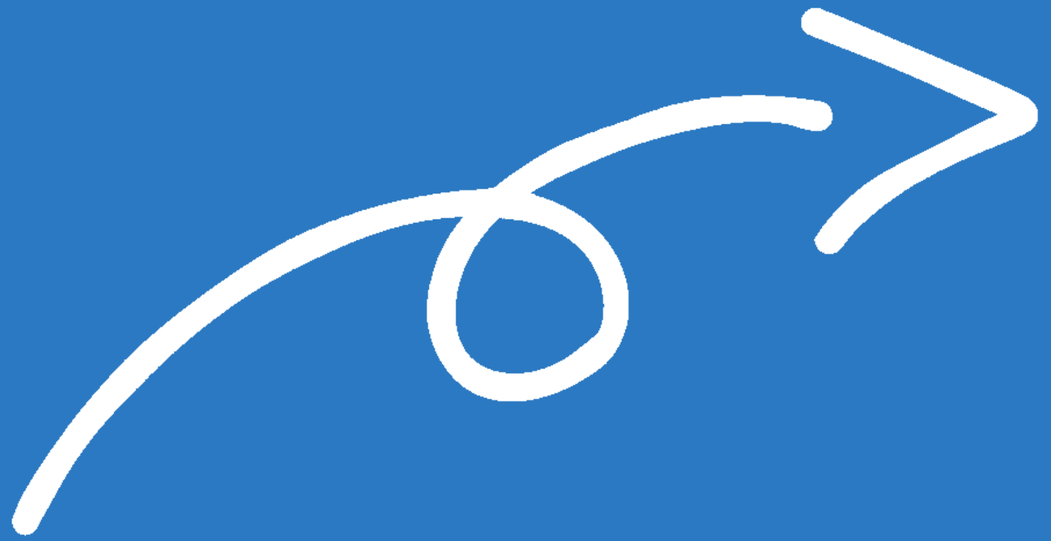
GENERATED DATA

The last parameters, which are weekly, monthly, and quarterly consumption were generated based on this conception:

- As in most cases the consumption of a person in a family of 3 members is relatively less if the same individual is in a family of 9 members. We called this effect (unconscious numerical bias) because by increasing the number of individuals they go without.

Consumption value + (consumption value x (number of people + 10/200))
Consumption value + (consumption value * (0.060 - 0.095))





Data Science Part

DATA SCIENCE

WHY USING PREDICTIVE ALGORITHMS?

- To go beyond knowing what has happened.
- To provide the best assessment of what will happen in the future.
- To identify the probability of future outcomes based on previous water consumption patterns and other factors.
- Aware the user of their future consumption, so they can take action before.

DATA PREPERATION

Importing the required libraries and reading the data.

Columns Headings	Description
User ID	Each user has a unique ID
Family member	The number of the user's family
Seasons	Which are Winter, Spring, Autumn, and Summer
Weekly	Weekly user's consumption
Monthly	Monthly user's consumption
Quarterly	User's consumption of the past 3 months

```
import pandas as pd
import numpy as np
from sklearn.linear_model import LinearRegression
from sklearn import metrics
import requests
import io
import warnings
import matplotlib.pyplot as plt
warnings.filterwarnings('ignore')
```

. Reading the generaed data, and printing the first five rows.

```
url=  'https://raw.githubusercontent.com/Duaa14/Meter/main/Meter.csv'
meters = pd.read_csv(url)
meters.head()
```

	User ID	family member	seasons	weekly	monthly	Quarterly
0	11666	8	Spring	7.11	33.14	83.61
1	75296	2	Summer	2.07	8.05	25.89
2	20350	4	Summer	4.70	15.89	55.92
3	94396	8	Winter	4.13	14.74	44.70
4	19178	9	Spring	8.63	30.77	102.08

Data Reading

Data pre processing

1

Encoding the categorical values to numeric for the prediction needs.

seasons
Spring
Summer
Summer
Winter
Spring

categorical values

seasons
3
4
4
1
3

Numeric values

Winter → 1

Autumn → 2

Spring → 3

Summer → 4

1. The 'User ID' was dropped since it won't be useful in the prediction.

Defining the X and Y ...

2. Determining the independent and the dependent variables.

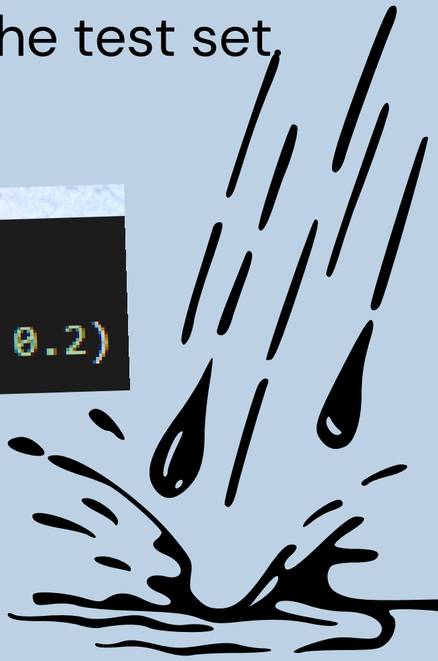
Family member
Weekly
Season
Monthly

Quarterly

```
meters= meters.drop(('User ID'), axis=1)
X = meters.drop(["by cycle"], axis=1)
y = meters["by cycle"]
```

3 Splitting the data into training and test sets, by using Scikit-Learn's built-in train_test_split() method. Where 80% for the training data, and 20% for the test set.

```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test = train_test_split(X,y,random_state=0, test_size = 0.2)
```



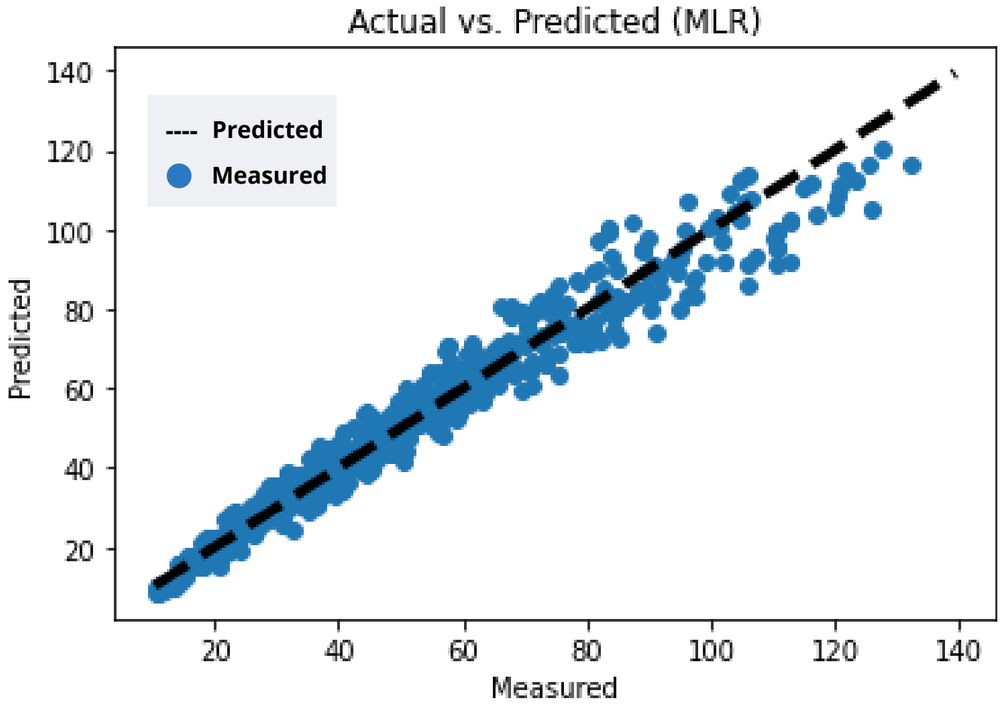
Multiple Linear Regression

R squared

0.953203

Mean Absolute Error

4.423128



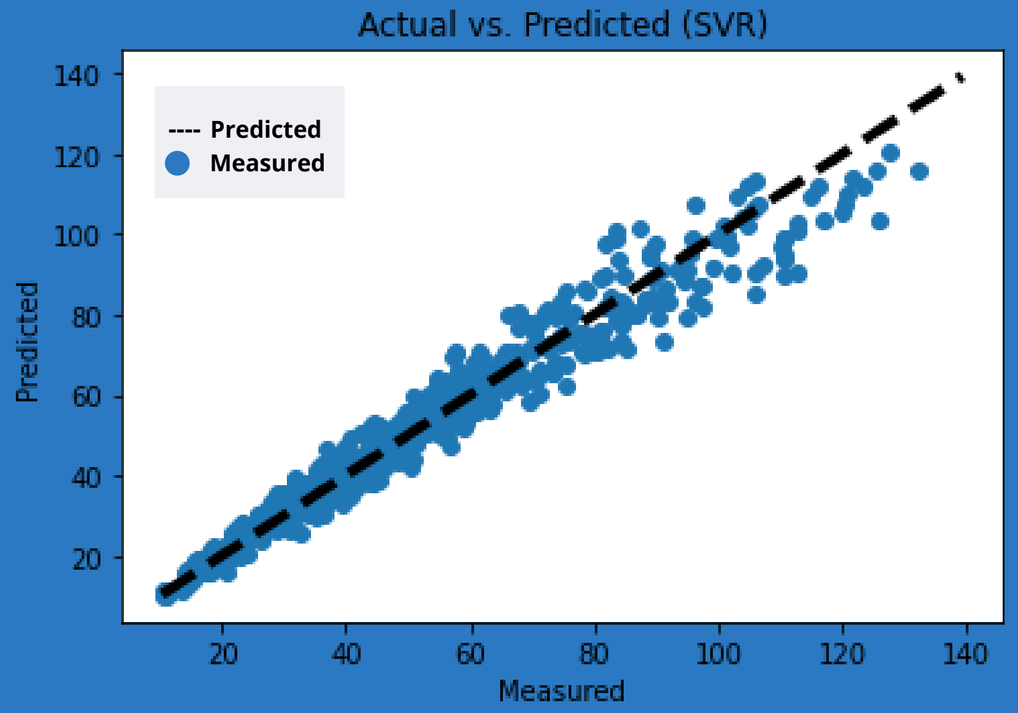
Supported Vector Machine

R squared

0.952550

Mean Absolute Error

4.369090



Comparison
Actual vs. Predicted

Actual	Linear Predictections	SVR Predictions	Linear Difference	SVR Difference
46.85	50.977667	49.924131	-4.127667	-3.074131
33.54	33.003381	33.215420	0.536619	0.324580
61.73	61.045383	60.754934	0.684617	0.975066
41.39	36.624006	36.630083	4.765994	4.759917

Comparison between the Actual and the predicted values in numbers

The Multiple Linear Regression Equation

	Coefficient
family member	2.481368
seasons	2.795319
weekly	4.785608
monthly	1.142562

Predictor, 'X-variable', independent variable

$$\hat{y} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_m x_m + \epsilon$$

```
print(linear.intercept_)
```

```
-7.315860848893642
```

Response, dependent variable, Quarterly

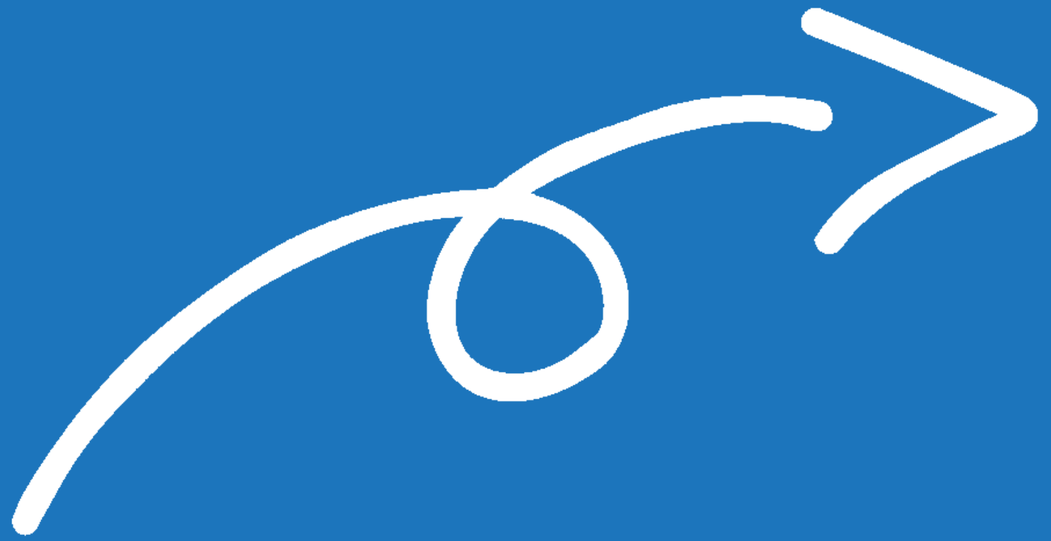
Random Error, 'noise'

B1 ⟶ Number of the family members
X1 ⟶ Coefficient of the family members

B2 ⟶ Season
X2 ⟶ Coefficient of the season

B3 ⟶ The value of the weekly consumption
X3 ⟶ Coefficient of the weekly consumption

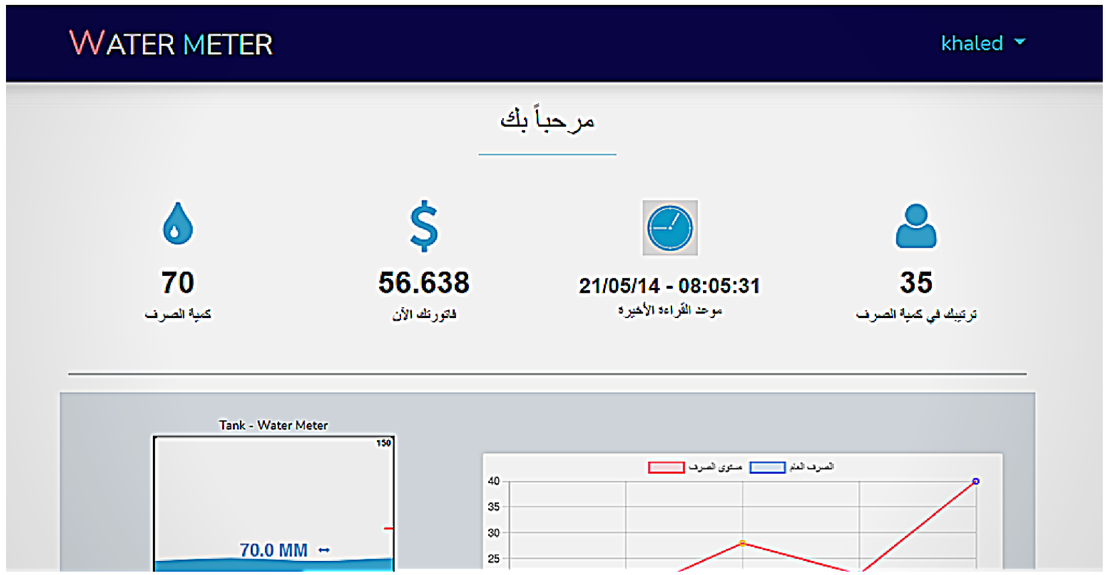
B4 ⟶ The value of the monthly consumption
X4 ⟶ Coefficient of the monthly consumption



Website Part

Data Science

Arduino

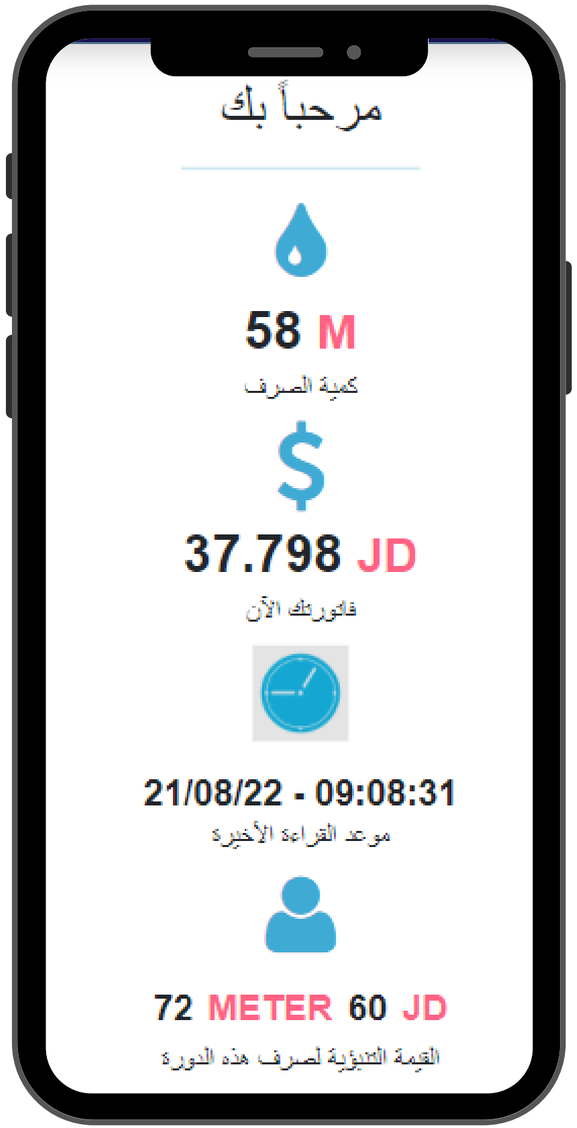


WEBSITE

WATER METER WEBSITE

MAIN INTERFACE CHARACTERISTICS

- Process and store the readings coming from the water clock
- Adding new customers through the admin to the DataBase
- Perform Data processing in the consumption equation
- Apply the prediction formula to display its result to the user
- Display Readings of current cycle of the user synchronously and directly.

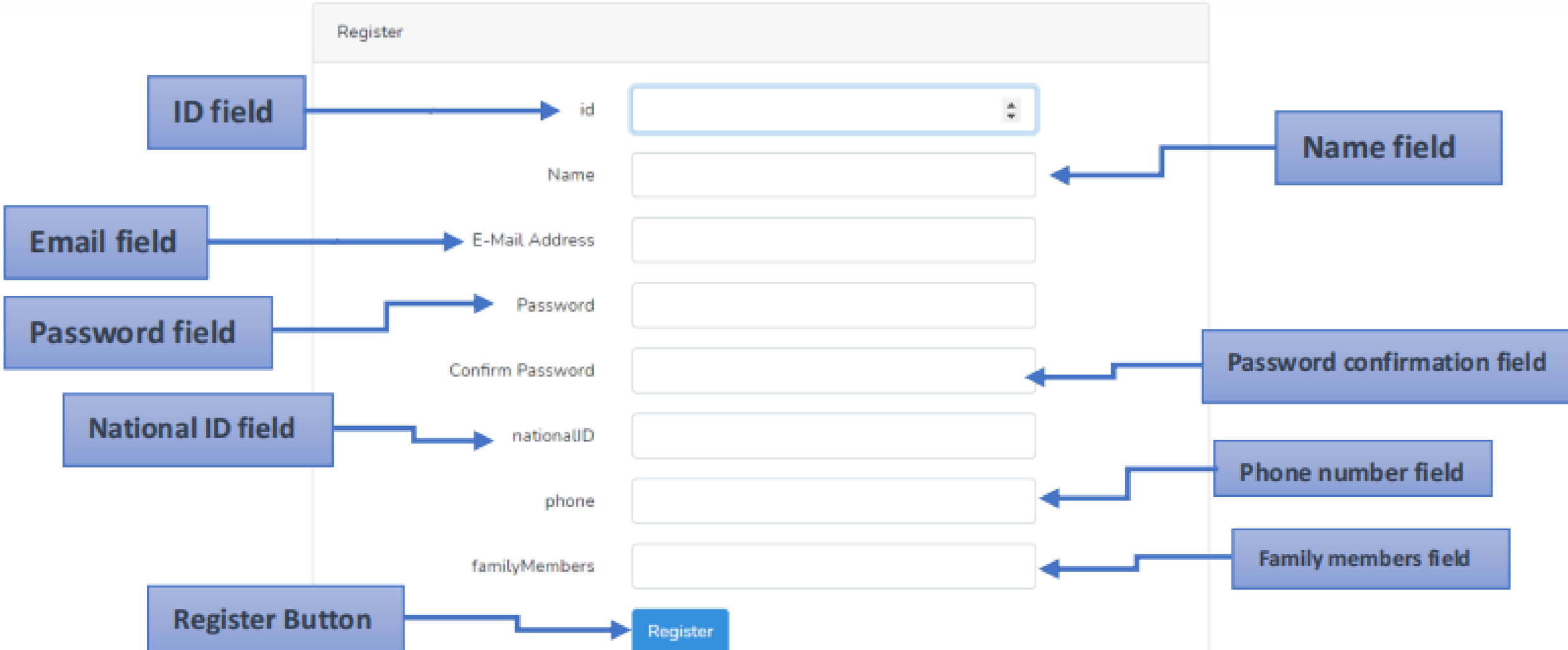


Client
Ahmad

Water meter
(ID = 867483)

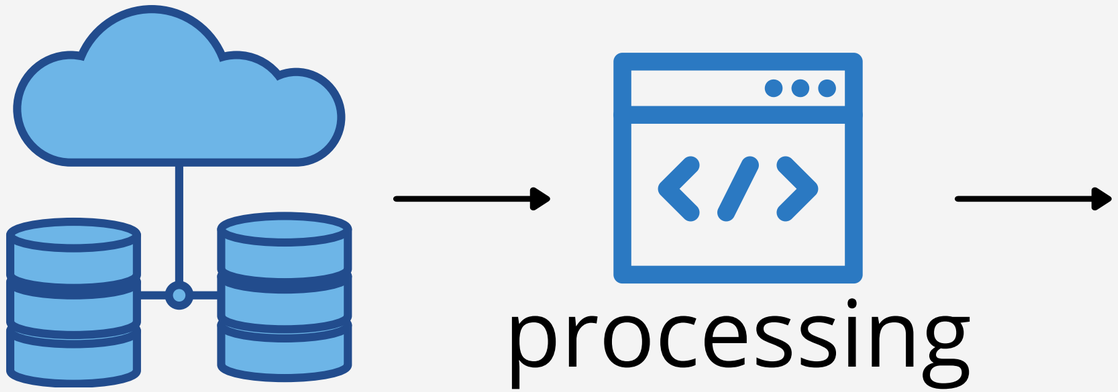
water meter
(ID = 867483
username=Ahmad
Family member=5 ...)

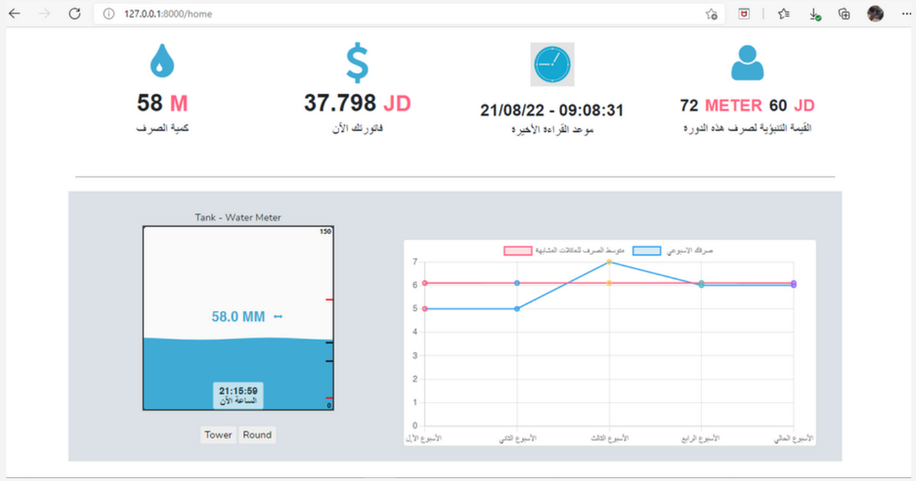
Registration page



01 Readings

02 log in user





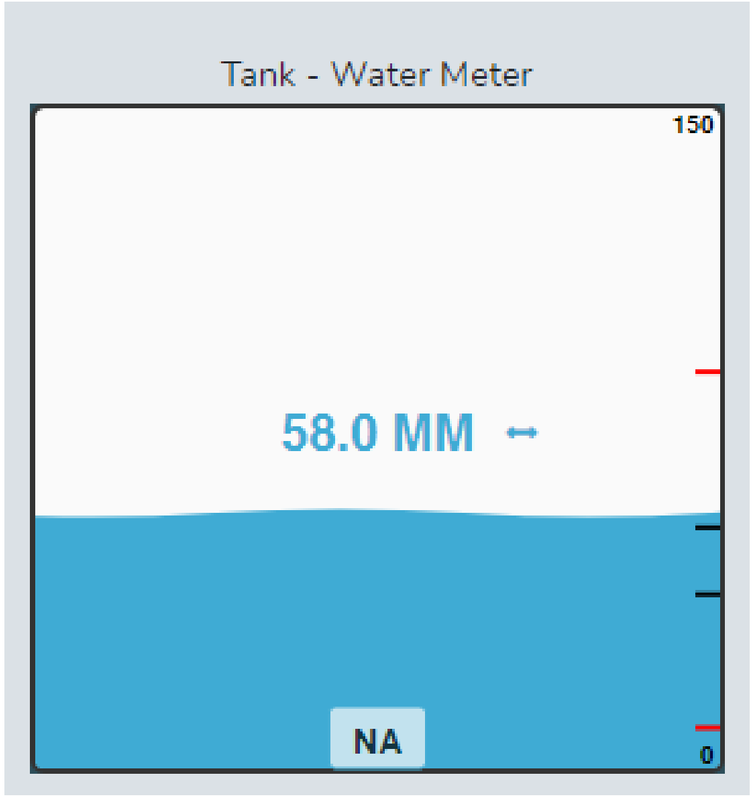
Home page

WEBSITE SERVICES

01 Water consumption value

This result is the total amount of water consumed in one cycle

One cycle equals 12 weeks which means it equals 12 records



WEBSITE SERVICES

02 Your bill now

The water bill is calculated through an equation extracted from the water bills and converted into a code that processes the entered value.

This equation based on the principle of accumulation, the greater the consumption, the greater the price per square meter

```php
public function cost ($sum)
{
    $allcost =0;
    switch ($sum){
      case($sum > 126):
          {
              $allcost += (($sum-126) * 3.02);
              $sum -=($sum-126);
          }
      case ($sum <= 126) && ($sum > 90) :
          {
              $allcost += (($sum-90) * 2.55);
              $sum -=($sum-90);
          }
      case ($sum <= 90) && ($sum > 72) :
          {
              $allcost += (($sum-72) * 2);
              $sum -=($sum-72);
          }
      case ($sum <= 72) && ($sum > 54) :
          {
```

The price per meter in JD for a specific category

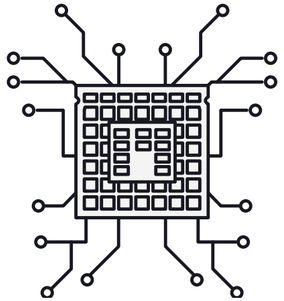
37.798 JD

فاتورتك الآن

WEBSITE SERVICES

03 Predictive value

The predictive value is displayed by entering the weekly consumption for the last week and month and processing them in the equation extracted from the predictive algorithm.



72 METER 60 JD

القيمة التنبؤية لصرف هذه الدوره

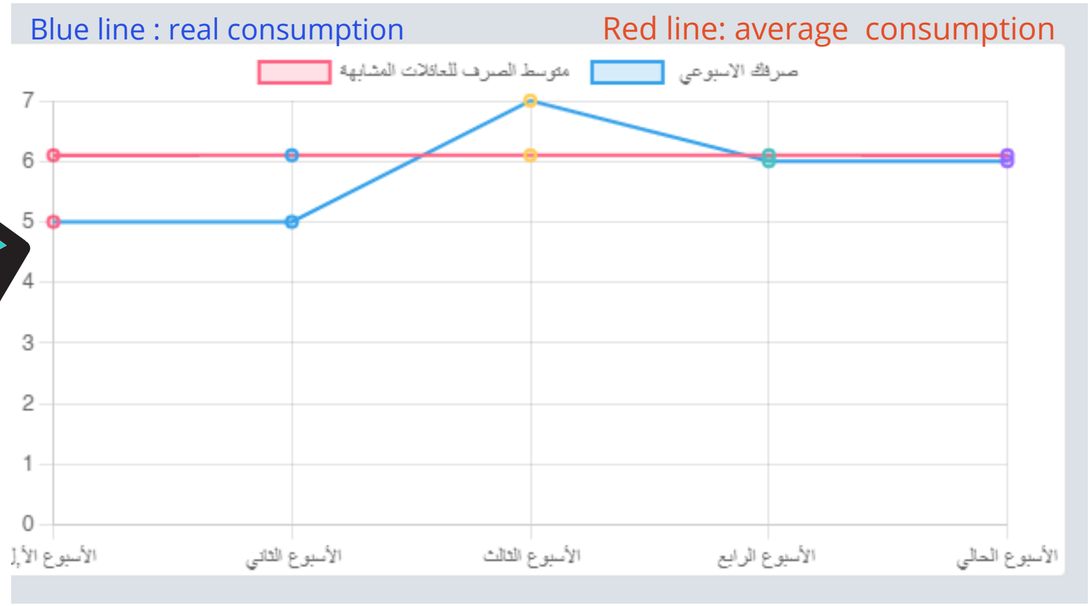
$Predictive value = -7.315860848893642 + (familyMembers'(*2.481368) + ($seasons*2.795319)+ ($weekly*4.785608)+($monthly*1.142562)

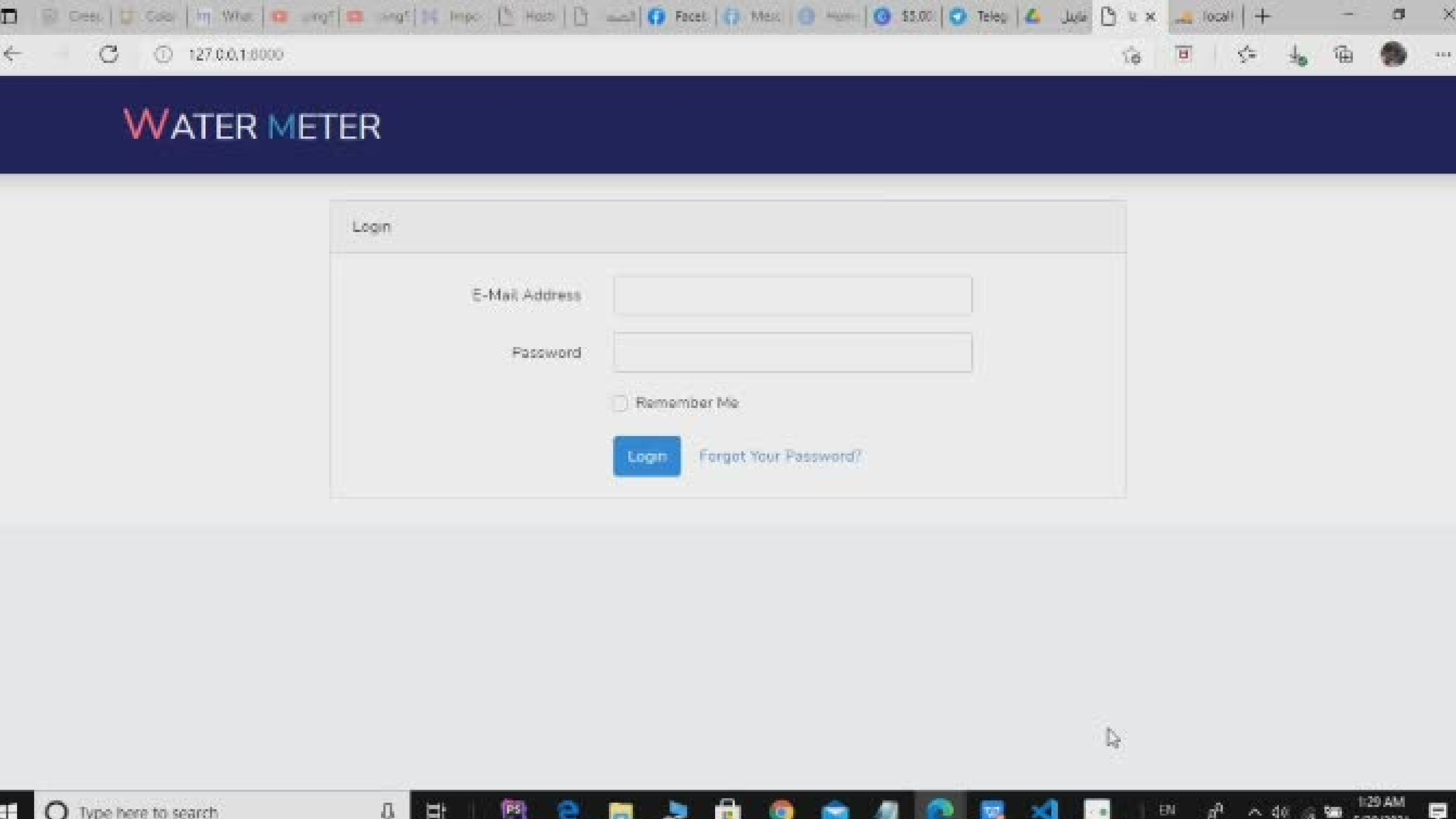
WEBSITE SERVICES

It helps the user in seeing the difference between real consumption and average consumption. By this, the user will know whether there is a decrease in consuming water and therefore it will as a notification for them.

04 Weekly consumption chart

This graph shows the consumption for the last five weeks. Also, the families with a similar average in consumption.



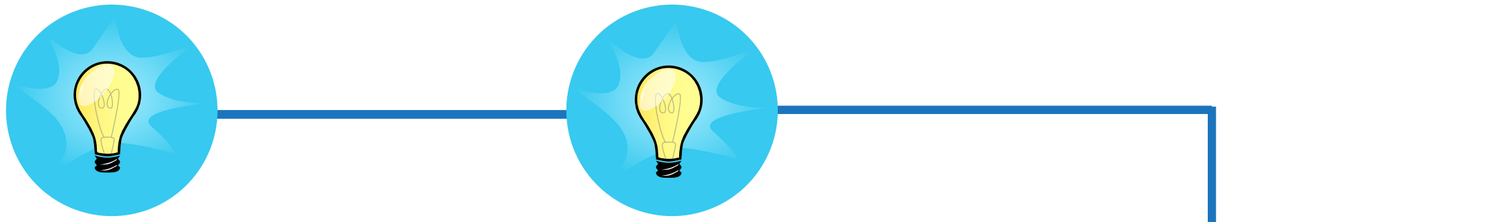

127.0.0.1:8000
WATER METER
Login
E-Mail Address
Password
Remember Me
Login
Forgot Your Password?

Languages used in website development

Front end

back end

Conclusion



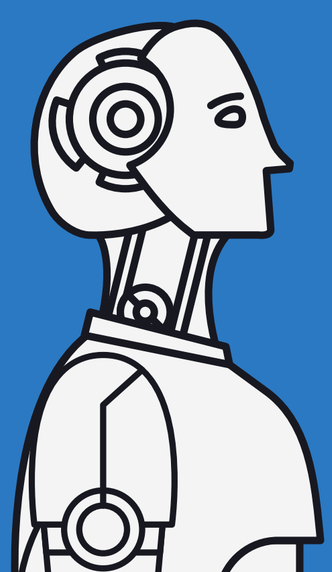
Smart water watch

User's consumption updated synchronously

Predictions of user's consumption

User's consumption value calculated in money.

Future Work



1. The user's data will be collected for analysis and prediction algorithms.
2. The users can pay their calculated bills through the system.
3. The warning notifications of an abnormal decrease or increase will be sent as SMS automatically to users.
4. An android version of the system will be developed.
5. The smart water watch will be charged through solar energy.