International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 11 | Nov 2025 www.irjet.net p-ISSN: 2395-0072

Designing Dashboard for Analyzing Daily Water Consumption per Capita in Saudi Arabia Regions Based on Data Science Concepts

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Abstract - *This study analyzes the average daily water consumption per capita across Saudi Arabia's thirteen regions in 2022 using data from the Saudi Open Data Portal. The dataset, managed by the Ministry of Environment, Water and Agriculture, was cleaned and visualized through Google Sheets and Looker Studio. An interactive dashboard with bar and pie charts highlights regional differences, showing the Central and Eastern regions with the highest consumption and Najran and Asir with the lowest. The results demonstrate how visual analytics can enhance understanding of national water use and support sustainability efforts. The designed dashboard is analyzed from security and privacy perspectives.*

Key Words: Water Consumption, Saudi Arabia, Data Visualization, Google Looker Studio, Sustainability, Security, Privacy

1. INTRODUCTION

Water is one of the most critical natural resources for human survival and economic growth. In Saudi Arabia, water sustainability has become a key national priority due to limited natural freshwater sources and increasing population demands [1]. This study explores official data published by the Ministry of Environment, Water and Agriculture, which reports the average daily per capita water consumption across the Kingdom's regions for 2022.

The objective is to analyze this data using modern data visualization tools and highlight consumption differences among regions. By building an interactive dashboard, this project aims to simplify the understanding of national water use and demonstrate how data visualization can support environmental awareness and policy planning.

1.1 Background and Objective

Water is an essential natural resource, and its sustainable use is a growing global concern. In Saudi Arabia, the scarcity of natural freshwater resources makes efficient consumption a top national priority [2]. The goal of this project is to analyze the average daily water consumption per capita across the thirteen administrative regions of the Kingdom for the year 2022 and visualize the findings through an interactive dashboard.

1.2 Problem Statement and Motivation

Understanding regional differences in water consumption is critical for developing informed conservation strategies. Although national averages are available, regional variations are not easily interpreted by the general public or policy makers. Therefore, this study leverages open government data and modern visualization tools to present regional consumption patterns in a clear and accessible form.

2. METHODOLOGY

This section is structures so that it presents a description about used data set and its resource, connection data set with dashboard, and visualization of data.

2.1 Data Collection and Preparation (Cleaning)

The dataset used in this study, entitled "Average Daily Water Consumption per Capita for All Regions of the Kingdom (2022)," was obtained from the Saudi Open Data Portal managed by the Ministry of Environment, Water, and Agriculture [3]. It contains 13 entries, each representing one administrative region of Saudi Arabia, and two attributes: Region and Average Daily Per Capita Consumption (Liters/day). The file was cleaned in Google Sheets by removing empty rows, translating Arabic headers to English, standardizing region names, and verifying values against the ministry source.

Table 1 summarizes the average daily water consumption per capita across Saudi Arabia's thirteen regions in 2022. The Central and Eastern regions recorded the highest levels (over 350 L/day), while Najran and Asir had the lowest (below 170 L/day). These variations reflect the influence of geography, climate, and population on water use across the Kingdom.

Table -1: Average Daily Water Consumption per Capita in Saudi Arabia's Regions (2022)

Region	Average Daily Consumption (L/capita/day)
Central	352.7
Eastern	352.4
Al Madinah	327.5

Makkah	305.2
Qassim	283.9
Riyadh	271.1
Hail	263.8
Tabuk	252.4
Northern Border	240.1
Jazan	225.3
Al Bahah	199.7
Asir	160.8
Najran	143.2

2.2 Data Connection and Visualization

The cleaned dataset was uploaded to Google Sheets and connected to Google Looker Studio using the Google Sheets connector [4]. The fields were configured as: Dimension = Regions, Metric = Average daily per capita consumption (Liters/day). Two visualizations methods were produced: (i) a vertical bar chart to rank regions by consumption; and (ii) a pie chart to show the proportional share of each region. Both charts were assembled into a single dashboard for side-by-side interpretation.

2.3 Bar Chart Based Visualization

The dataset provides the foundation for the visual analyses presented in the following sections, allowing regional trends to be interpreted more effectively through the accompanying charts and dashboard visualizations. Figure 1 illustrates the data set in terms of histogram (i.e., regions against average of falls).

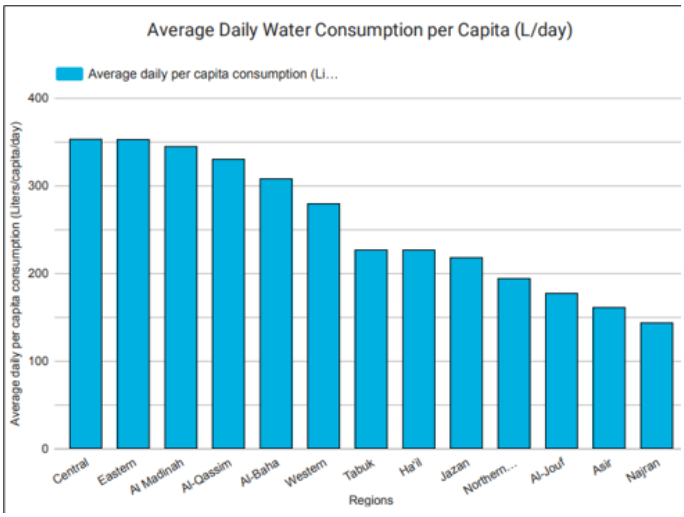

Fig – 1: Vertical Bar Chart of Regional Average Daily Per Capita Water Consumption (L/day)

The Bar chart ranks the 13 administrative regions by their average daily water consumption per capita. The Central and Eastern regions recorded the highest consumption, while Najran and Asir had the lowest. The chart allows for easy visual comparison across regions.

2.4 Completed Dashboard

Figure 2 illustrates the overall designed dashboard based on combination of the data represented by the Bar chart, Pie chart, and Labels of data.

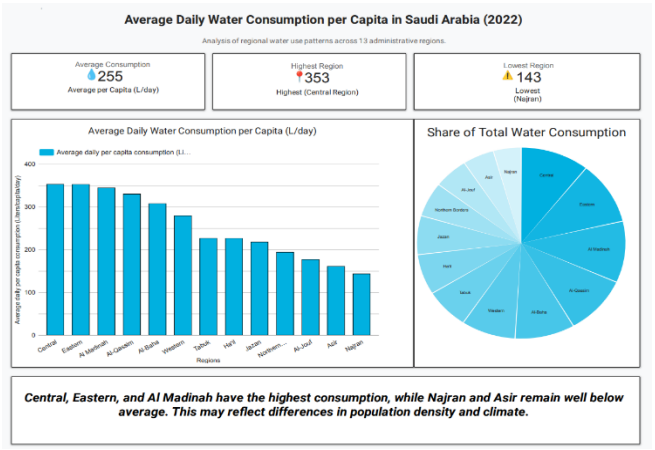

Fig -2: Dashboard showing regional comparison of water consumption (KSA, 2022)

The Looker Studio dashboard combines bar and pie charts to visualize both ranking and proportional share of water consumption among all 13 regions, where results are collected automatically in three labels of data. It highlights regional variation, supporting data-driven insights for sustainability awareness and planning.

The combination of Table-1, Figure 1, and Figure 2 provides a complete view of regional water consumption patterns in Saudi Arabia. The table presents the raw values from the official dataset, while the bar chart emphasizes differences between regions, and the dashboard integrates both charts into an interactive visualization. Together, these tools illustrate how data visualization can transform numerical data into clear, interpretable insights that support decision-making and sustainability awareness.

3. RESULTS AND DISCUSSION

This section provides results of dashboard with details related to the average of water falls and their exploration. Then, a discussion based on security and privacy of data ie presented.

3.1 Results

The dashboard visualization clearly highlights regional differences in water consumption across Saudi Arabia. The

Central (352.7 L/day) and Eastern (352.4 L/day) regions recorded the highest per capita consumption, while Najran (143.2 L/day) and Asir (160.8 L/day) reported the lowest. The overall national average was approximately 299 L/day. These variations can be attributed to factors such as urbanization, industrial activities, and climate differences.

The interactive Looker Studio dashboard allows for clear comparison across regions and provides a data-driven foundation for water sustainability awareness and policy discussions.

3.2 Security and Privacy Based Discussion

Security is an important aspect in data science, where it must be protected during data analyzing and presenting. As the data obtained from internet, some web application security controls can be applied for the purpose of protection [5]. This work can be enhanced when taking into consideration such techniques. Moreover, the data collection, analyzing, and cleaning can be done using smart agents [6]. However, security of agents is critical if taking into account that host machines can act as malicious party. In the work [7], a method can be used to enhance security of the dashboard by generating multiple tasks (one of them is real and the rest are false). Furthermore, self protection approach [8] can be implemented to enable more data protection level using encryption method. Since designing dashboards is strongly linked with big data and its related techniques. data mining methods accompanied with security methods can be used to enhance the security level of presented data within the dashboard [9].

As for privacy of data, protection privacy of both information of users and sensitive data is important. The privacy issue can be highlighted through the following scenario:

1. Users are requested to create accounts to login the dashboard. In this step, personal information are entered, such as ID, Address, Age, Affiliations, and interests.
2. After creating accounts, login can be performed using smart mobiles based on location of users.
3. Queries are performed on the dashboard to retrieve results.
4. Results are displayed on dashboard along with the personal information.

The previous scenario reveals some privacy issues related to the dashboard, which can be listed as follows:

1. For the first step, personal information can be tracked by attackers. Attackers can collect sensitive data about users and may use them later for blackmail for an example. Actually, work [10] presented a comprehensive study related to privacy issue.
2. For second step, locations of users using GPS can be tracked and analyzed by attackers, which leads to a privacy concern. In this context, some enhancement can be done using some approaches provided in [11-13] as well as enhancing power consumption when execution of the dashboard on mobile devices.
3. For third step, analyzing of sent queries may be analyzed and linked to the ID of users, and opens door for attackers to collect more personal data about users. In this aspect, enhancement on the dashboard can be performed using the method presented in work [14].
4. For last step, obtaining and visualizing data on the dashboard can be presented using deep learning techniques. In this context, some approaches can be performed to enhance the quality of the dashboard and its privacy level using work [15] for an example.

4. CONCLUSION

This study demonstrated how open data combined with visualization tools can simplify understanding of national water consumption patterns. The Central and Eastern regions showed the highest per-capita usage, while Najran and Asir showed the lowest. The Looker Studio dashboard offers an accessible way to present data and encourages better awareness of regional disparities. Many security and privacy issues are addressed with some proposed methods for the purpose of enhancement.

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