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Data Visualization of Organ Donation Trend in Malaysia

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ABSTRACT

Malaysia now faces a huge challenge in dealing with the growing demand for organ transplants, with the number of organ donors limited despite ongoing government efforts to increase registration. The absence of dynamic and interesting tools to monitor and visualize organ donation trends in Malaysia hinders efforts to raise awareness and encourage participation. This research focuses on identifying system requirements, designing, and developing data visualizations that showcase Malaysian organ donation trends from 2014 to 2023 using data from the National Transplant Resource Center (NTRC). The main objective is to develop an interactive dashboard that illustrates the trend of organ donation Malaysia, offers key insights for policymakers and the public to deepen their understanding of these patterns. Additionally, the dashboard will act as an important resource for the public, researchers and government health agencies, equipping them with detailed information to improve strategies and initiatives related to organ donation. To ensure efficient development, the Waterfall model is combined with the OSEMN framework to guide data processing and visualization tasks. The research integrates data visualization techniques into an interactive dashboard, utilizing tools such as Power BI and Python libraries for data processing and graphical representation. At the end of the research, it can be concluded that, while efforts are being made to increase organ donation rates, further improvements are needed to ensure that Malaysia's organ donation system can meet the growing demand and improve public participation.

1. Introduction

The act of donating bodily organs or tissues to those in need of transplantation due to organ failure or injury to the recipient's organs is known as organ donation. There are two primary types of organ donors: living donors and deceased donors. This medical intervention, capable of greatly enhancing or preserving the life of the recipient, pertains to both living people and deceased donors, the latter being individuals who have undergone either circulatory death or brain death [1]. Organs frequently transplanted consist of kidneys, liver, heart, lungs, and pancreas, whereas transplantable tissues are skin, bones, eyes, and heart valves. Consequently, a single donor can potentially save numerous lives. The patient can continue to live a better life following transplantation. Organ

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transplantation, on the other hand, is the process of moving human cells, tissues, or organs from a donor to a recipient in order to restore bodily functioning [2].

Although demand for organ transplants is increasing in the country, major challenges persist in increasing donor awareness and participation. Organ transplantation remains the only option to prolong the life of individuals with end-stage organ failure while improving their quality of life [3]. Unfortunately, the considerable gap between the supply of donated organs and the increasing demand results in the loss of numerous lives. In Malaysia, the government's initiatives to promote organ donor registration fall short, resulting in an ongoing widening of this gap. Cultural and contextual elements specific to nations affect the readiness to donate organs [4]. Each year, the demand for organs keeps increasing. As of Malaysia's lack of organ donors, individuals on transplant waiting lists face a higher risk of dying. Data from the Malaysian Society of Transplantation indicates that there are presently 9,608 patients awaiting life-saving transplant surgeries [5]). Kidney transplants are in the greatest demand, both for adult and paediatric cases [6]. Despite the rise in patients requiring organ transplants each year, the readiness to donate organs posthumously remains low.

There are three objectives for this study which are: I) To identify the system and data requirements for Data Visualization of Organ Donation Trend in Malaysia; II) To design Data Visualization of Organ Donation Trend in Malaysia; and III) To develop the Data Visualization of Organ Donation Trend in Malaysia. The scope of this study focuses on datasets of organ donation project from the year 2014 until 2023, where the source of the dataset is from National Transplant Resources Centre (NTRC). The scope also includes the visualization of organ donation trends that cover all states within Malaysia, where the developed techniques will encompass various visualization methods, such as graphs, charts, maps, and interactive dashboards to indicate visualization and analysis the trends of organ donation.

This study aims to examine the trends in organ donation throughout Malaysia over different periods. By collecting pertinent information from different sources and utilizing intuitive data visualization tools, it seeks to offer a straightforward visual representation of the current conditions and advancements in organ donation within the nation. The goal is to emphasize key trends, pinpoint areas for enhancement, and facilitate informed decision-making to advance organ donation efforts in Malaysia.

2. Literature Review

2.1 Organ Donation

Organ donation entails providing an organ or a portion of it to another person for the aim of transplantation [7]. This medical intervention, capable of greatly enhancing or preserving the life of the recipient, pertains to both living people and deceased donors, the latter being individuals who have undergone either circulatory death or brain death [1]. The use of essential organs to save the lives of others is made possible by this legal and medical recognition, which streamlines the donation process [8].

Due to a mix of informational, religious, and cultural hurdles, Malaysia has one among the lowest rates of organ pledgers. Pledging one's organs is greatly discouraged by cultural beliefs and misconceptions, such as worries about the afterlife's reaction to organ donation or delays in funerals. Furthermore, the significance and procedure of organ donation are not well understood or taught. The low rate of organ pledges in the nation is a result of these circumstances as well as the lack of robust, ongoing lobbying and support from institutions and community leaders [5].

According to a study by Alwahaibi *et al.,* [9] on university students in Oman, 34.1% of them knew enough about brain death, 70.2% had a negative attitude toward it, and 34.1% had strong awareness regarding organ donation. Culture and religion have also been identified as significant influences on the decision-making process regarding organ donation. Therefore, it is essential to evaluate the knowledge and attitudes of the general population towards organ donation.

The greatest and most economical clinical option for end-stage organ failure is still organ donation and transplantation [10]. The approach for organ donation because the brain-dead patients would still be on life support because the organs were still fresh from the oxygen supply obtained through ventilators [11]. A significant issue connected to the global organ scarcity, impacting numerous nations including Malaysia, is the lack of adequate organ donors. The low level of organ donation in Malaysia is due to insufficient knowledge about the process, distrust of the healthcare system, and minimal awareness of the steps to become an organ donor. Naghavi [4] notes that although the government has worked to encourage donor registration, the disparity between the need for and availability of organs for transplantation keeps growing. To tackle this problem and boost donation rates, comprehensive education and awareness initiatives are essential to dispel myths, deliver correct information, and foster trust in the organ donation process and healthcare system. Moreover, adopting ethical and transparent practices within the healthcare system can alleviate public anxiety, motivating more people to donate their organs [5]. A significant number of individuals believed that organ donation is allowed in Islam and viewed it as a communal duty. However, a similar proportion of people were uncertain about whether donors would be rewarded for their organs or if Islam permits the retrieval of organs from brain dead patients. Malaysian Muslims generally do not oppose organ donation. Thus, to encourage organ donation, the state needs to address public concerns regarding Islam's stance on this sensitive issue. Effective policy tools are needed to bridge the gaps in Malaysian Muslims' understanding of organ donation.

2.2 Big Data and the Characteristics

The phrase "big data" has become widely used to describe the enormous volumes of data that are produced daily by individuals, businesses, and devices all around the world in our digitally connected society. Big data is now regarded as a crucial topic in the business and IT domains. Big data is what keeps many businesses and organizations competitive and running smoothly [12]. Big data is defined by five main attributes namely volume, variety, truth, value, and velocity. Diversity includes the various kinds and sources of data in Big Data, such as structured, semi-structured, and unstructured formats obtained from social media, sensors, and mobile devices [13]. This information can exist in different formats, including text, audio, image, and video.

According to Sivakumar [14] The outcome of big data analysis is data visualization which is a process of translating the complex set of data into graphical representations such as charts, maps, graphs, plots, infographics, and even animations to make data easier for the human brain to understand and pull insights from. People are typically taken aback by the immense and complex data [15]. The primary benefit of data visualization is its capacity to convey intricate data in a manner that stakeholders can grasp easily, aiding in revealing insights and facilitating decision making.

Data visualization is crucial for enabling data-driven decision-making and supporting strategic planning in sectors like business, healthcare, and policy. It aids in identifying patterns, trends, and anomalies, enabling organizations to utilize their data more efficiently [14]. Data visualization techniques are essential for effectively representing complex datasets, enabling users to analyse and interpret information efficiently.

2.3 Big Data Application on Organ Donation Trend (System Review)

There are five (5) existing systems, as shown in Table 1, that are comparable to the project Data Visualization of Organ Donation Trend in Malaysia namely I) Organ Transplantation Dashboard (GODT); II) Organ Transplantation Dashboard (OPTN); III) Organ Transplantation Dashboard (NOTTO); IV) Organ Donation Dashboard (Canadian Organ Donation); and V) Organ Pledger Dashboard (KKMNOW). It's crucial to examine current systems because it offers a thorough understanding of the current environment, uncovers best practices, and identifies potential challenges. Based on the reviewed system, there are few features that have been identified in order for improvement for the project and references.

Table 1
Summary of review existing system

Dashboard	Organ Transplant Dashboard (GODT)	Organ Transplant Dashboard (OPTN)	Organ Transplant Dashboard (NOTTO)	Canadian Organ Donation Dashboard	Organ Pledger Dashboard (KKMNOW)	Proposed Dashboard: Organ Donation Trend in Malaysia Dashboard
Flexible sharing		✓			✓	✓
Accessibility	✓	✓			✓	✓
Clarity		✓	✓	✓	✓	✓
Filters			✓	✓		✓
Interactivity	✓			✓		✓
Whitespace	✓	✓	✓	✓	✓	✓

The primary objective of this project is to create the proposed dashboard, Data Visualization of Organ Donation Trend in Malaysia. The Organ Donation dashboard encompasses various variables such as location, state, types of organs, number of transplants, year, and other pertinent factors related to organ donation. Data will be displayed using bar charts, pie charts and other more charts. Additionally, the dashboard will feature interactivity, enabling users to engage with elements like filters and buttons. However, the introduction of these interactive elements will be phased in as needed to enhance the system.

3. Methodology

3.1 Model and Framework

This project will integrate Waterfall Model from the Software Development framework and OSEMN as in the Data Science Lifecycle framework. The OSEMN framework offers an organized method for managing data from the initial gathering to the ultimate analysis, encompassing the Get, Scrub, Explore, Model, and Interpret phases. This organized but adaptable approach guarantees precise data handling and efficient analysis, leading to trustworthy and significant visual displays. The Waterfall model enhances project management and oversight by offering a clear and straightforward roadmap from beginning to end, facilitating resource allocation, progress monitoring, and the achievement of project goals.

This project improves OSEMN by incorporating Waterfall architecture to facilitate Big Data Analytics, thereby contributing to the foundational structure. The Waterfall framework offers an

organized workflow that, while mainly linear, can be modified to incorporate iterative detection and resolution of issues.

3.1.1 Plan Phase

The first stage of the approach is the planning stage, concentrating on identifying and comprehending the main problems of the project. This stage is crucial in data visualization as it guarantees that objectives are defined accurately, data is gathered properly, and the best visualization methods are selected, all of which help convey insights clearly and efficiently. In this stage, a comprehensive literature review was carried out, utilizing sources like UiTM Library Research and Google Scholar. This study offers a comprehensive insight into the issue and its associated fields. Investing adequate time and effort in this stage guarantees a clear path and alignment with anticipated results. Important outputs from this stage consist of the problem statement, project scope, specific objectives, and the project's significance. Additionally, a list of hardware and software requirements is compiled to assist in project execution, and the project schedule is created using the Gantt Chart method, implemented with the Canva tool. The primary deliverable for this project is a comprehensive Gantt chart.

In addition, system review is also used to ideate solutions to solve the problem. In detail, the extraction steps were done in this phase which ETL tool is used to extract the data from various data source systems during this phase. The techniques will include obtaining data and scrubbing data. Data scrubbing is a critical step that ensures the data is accurate and usable for creating reliable models, visualizations, and for informed decision-making. The expected outcomes include a problem statement, objectives, scope, and raw datasets needed for developing the data visualization.

3.1.2 Design Phase

The second phase in the data science project is the design phase accomplishes the object of designing the project. The design phase includes the activity of the data cleaning process involves using the technique of scrubbing data with tools like Python and Jupyter Notebook to produce a dataset without missing values. Additionally, designing the dashboard, which serves as the visual interface for presenting the data. The techniques employed in this activity typically involve storyboarding, which is the process of sketching out the layout, structure, and visual elements of the dashboard. Initially, hand sketches were created to conceptualize the design, and then software sketching tools which like Canva were used to translate the initial sketches into a digital format. The outcome of this process is a low-fidelity prototype which consists of system interface design and wireframe.

3.1.3 Build Phase

After the design phase, the build phase is implemented to fulfil the third objective, which is to develop data visualization of organ donation trend in Malaysia. This phase is critical where the system will be developed. This crucial phase in the ETL process is data loading. The target database is loaded in this stage with the extracted and transformed data. Another task in the phase is developing the dashboard system. Expected deliverables are a datastore and data model while developing system is the dashboard system will be created.

3.1.4 Test Phase

The last phase is the testing phase which focuses on the evaluation of the final data visualization to determine whether it has achieved the project's goals. In this phase, there were two types of testing that were conducted which are system testing and usability testing. Software testing is the process of verifying and validating that a software or application is free of bugs, meets its technical design and development requirements, and fulfils user requirements efficiently and effectively by managing all exceptional and boundary cases. System testing involves the integration checking method, which verifies whether the data visualization functions as intended and aligns with the project objectives. If any bugs or errors are detected, the necessary repairs and adjustments are made before proceeding to the next testing phase. Using the technique of integration checking and debugging to test the system and system usability scale as well as system debriefing in the usability test, an error can be detected based on the result of the test. Therefore, the design and development process help in the improvement of the dashboard system. The deliverables are a checked dashboard system, user feedback acquired at the end of a phase, and the aim of this project which is an improved dashboard system.

After verifying the performance of all data visualizations, usability testing was conducted. This testing involves specific users interacting with the visualizations to achieve predefined goals within a given context. The primary aim is to evaluate user effectiveness and satisfaction. During this phase, the System Usability Scale (SUS) tools and techniques are utilized. SUS includes a set of questions designed to gather user feedback on the data visualizations, offering valuable insights for further enhancement. Since the duration of the research is only five months to complete, therefore in the future the researchers suggested more detailed and comprehensive testing should be done in order to get better findings for the research.

This chapter provides an overview of the integration between Agile methodology and OSEMN framework that is being applied to develop the data visualization of Organ Donation Trend in Malaysia. This involves detailing the activities and outcomes for each phase. Each phase is aligned with the project goals established in the previous chapter, ensuring that all objectives are met by the project's end. Therefore, it is crucial to follow each step of this process meticulously to efficiently produce the data visualization.

4. Results

4.1 Identification of Data and System Requirements

This study needs a large amount of data, particularly about Organ donation trends in Malaysia, to meet its objectives. Additionally, reliable hardware and updated software are crucial to ensure smooth development, proper functioning, and fewer technical problems. These key requirements will be explained in simple terms, focusing on the 5Vs of big data that are relevant to handling large datasets.

4.1.1 Data Requirement

The first V in 5Vs of big data characteristics is volume. Naturally, the size of the raw data itself will come up first if big data is listed or usually mentioned. The National Transplant Resources Center (NTRC) provided the raw datasets for this research. The dataset is in CSV format and spans a 10-year period from 2014 to 2023, encompasses organ donation, age of donor and recipient, gender, ethnicity, geographical and district sourced from National Transplant Resources Center (NTRC).

The dataset is necessary to display organ donation trends in Malaysia, covering information such as types of organs donated, the number of donations per year, donor and recipient demographics, and state and district details of organ donors. However, not all attributes from the dataset will be used for the dashboard. It is important to evaluate each attribute to determine its meaning, relevance, and data type. The process of classifying the attributes is essential before performing data cleaning and preparation, ensuring that the final dashboard effectively represents the required information. This paper only discussed part of the findings from the dataset. The full dataset can be obtained from the researcher's full report.

4.1.2 System Requirements

System requirements are not only about the functional and non-functional requirements but also include software and hardware requirements. The functional requirements include the chart options, data filtering and dynamic visualization. Whereas the non-functional requirements comprise the platform compatibility, performance and responsive, usability of the dashboard, and the dashboard interactives. The hardware components include the personal laptop with specification of AMD Athlon Silver 3050U with Radeon Graphics for the processor. While the software components required operating system of Window 11, Python and Anaconda Jupyter Notebook for programming, also Microsoft Power BI to create visualization dashboard.

4.2 Designing Organ Donation Trends in Malaysia Dashboard

4.2.1 Storyboard Concept

A storyboard is created to better understand the project's goals. It acts as a visual guide that highlights the main problem driving the project such as shown in Figure 1.

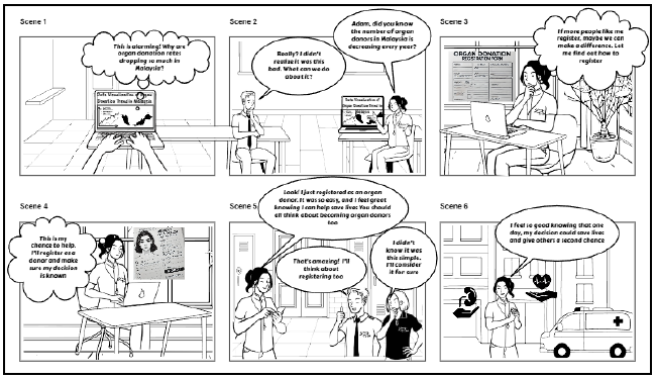

Fig. 1. Storyboard Concept of Organ Donation Trend in Malaysia Dashboard

4.2.2 User Interface Design

Creating a simple dashboard sketch which also known as a low-fidelity prototype, is made using a Canva template, outlines the basic layout, key features, and overall structure of the dashboard without focusing on detailed functionality. It's an important step to confirm the design ideas and make smart decisions before spending time and resources on more detailed development. This paper only shows part of the sketch made. The full sketch can be obtained from the researcher's full report.

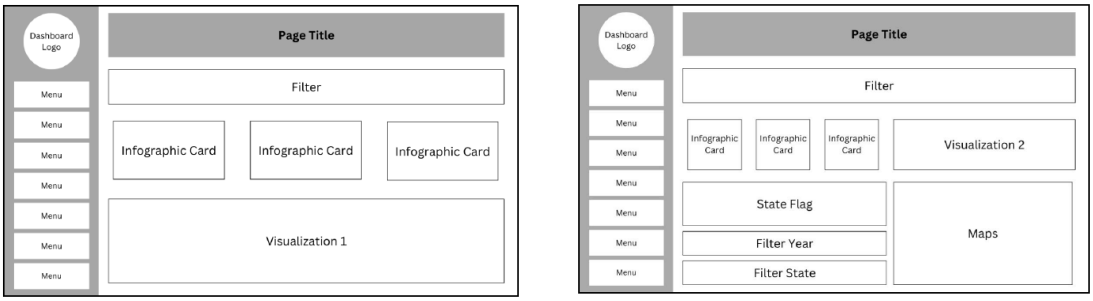

Fig. 2. Design Model Sketch

Figure 2 shows the early design of the Organ Donation Trend dashboard interface. The design highlights the placement of buttons, page navigation, and layout for each visualization planned to be included in the system. This sketch can also be classified as the system wireframe as it outlines all the page designs and shows the sequence of the dashboard.

4.2.3 Dashboard Flowchart and Use Case Diagram

Flowcharts are essential for any system or website development project as they illustrate how the system is intended to function. In this study, the dashboard's flow is depicted using various symbols.

Use case diagram is used to illustrate how the system functions in specific scenarios. Although the system is designed for various stakeholders, including the general public, researchers, and government health agencies, it provides a consistent interface for all users, as there are no specific role requiring unique permissions. The dashboard system itself is treated as an actor, as it processes and responds to user interactions. The use case diagram also describes the sequence of activities and possible variations that users can follow to achieve the system's goals.

4.3 Building Organ Donation Trend in Malaysia Dashboard

4.3.1 Data Preparation

The National Transplant Resources Centre (NTRC) has provided a dataset in excel format. 5 sheets of documents, consisting of types of organ donation by year, age of recipient and donor, gender of recipient and donor, ethnicity of recipient and donor and state for recipient and donor.

The raw dataset provided by the National Transplant Resource Centre (NTRC) is well-structured and organized in tabular form, making it possible for further analysis and dashboard development. The dataset contains various attributes such as year, types of organs donated, donor and recipient details, age groups, and gender distribution. However, upon initial examination, the dataset includes some null values, which indicate missing information in certain rows or columns. To ensure data accuracy and usability for the dashboard, data cleaning processes are necessary. These processes involve handling null values, standardizing formats, and ensuring consistency across all fields. The datasets for which Jupyter Notebook, the data cleaning tool, and the Python programming language have been used to clean the data. Several steps have been taken to ensure the data is organized and standardized, making it easier for visualization tools to interpret the data and accurately display each chart or visualization output.

4.3.2 Data Modelling

Figure 3 illustrates the process of utilizing the pandas library in Python for loading, cleaning, and modifying an organ donation dataset. Initially, the dataset is imported into a pandas DataFrame from an Excel file OrganDataset.xlsx by specifying the file path and sheet name OrganDonation.

```
In [1]: import pandas as pd

In [4]: #Load the excel file into dataframe
        file_path = r"C:\Users\nrsya\Desktop\DEGREE SEM 5\FYP\OrganDataset.xlsx"
        data = pd.read_excel(file_path, sheet_name='OrganDonation')
        print(data.head())
```

	Year	Organ	Donor	Recipient	Procure	Transplant
0	2014	Cornea	35.0	64.0	49.0	49.0
1	2015	Cornea	32.0	66.0	68.0	60.0
2	2016	Cornea	10.0	20.0	26.0	16.0
3	2017	Cornea	17.0	29.0	6.0	5.0
4	2018	Cornea	9.0	17.0	14.0	10.0

Fig. 3. Load organ donation sheet

The program then identifies and handles any missing data within the dataset. It tallies the quantity of null values in every column utilizing the is null () and sum () functions. To ensure data consistency, the fillna(0) function substitutes these absent values with 0. The information is subsequently transformed into integer format for additional processing.

Figure 4 shows a new Excel file titled Organization_modified.xlsx is generated, which includes the cleaned dataset. This pre-processing phase guarantees that the dataset contains no missing data and is ready for precise analysis and visualization of organ donation trends.

```
In [6]: #save the modified dataframe to a new Excel file
        data.to_excel(r"C:\Users\nrsya\Desktop\DEGREE SEM 5\FYP\OrganDonation_modified.xlsx", sheet_name='OrganDonation', index=False)
```

Fig. 4. Save the modified organ donation sheet to new excel file

The Figure 5 illustrate the steps involved in loading and preprocessing the Age sheet from the OrganDataset.xlsx file using the pandas library in Python. The dataset is first imported into a pandas DataFrame by indicating the sheet name Age and the file location.

```
In [16]: #Load the excel file into dataframe
         file_path = r"C:\Users\nrsya\Desktop\DEGREE SEM 5\FYP\OrganDataset.xlsx"
         data = pd.read_excel(file_path, sheet_name='Age')
         print(data.head())
```

	Year	Age	Donor	Recipient
0	2014	0 - 9	2.0	8.0
1	2014	10 - 19	5.0	14.0
2	2014	20 - 29	6.0	14.0
3	2014	30 - 39	10.0	16.0
4	2014	40 - 49	13.0	27.0

Fig. 5. Load Age sheet

The print(data.head()) command is utilized to show the initial five rows, featuring columns like Year, Age, Donor, and Recipient, which illustrate the age distribution of organ donors and recipients. Missing values are addressed by utilizing Data.fillna(0), substituting them with zero. To guarantee consistent data formatting, lambda functions are employed to transform float values into integers. Once the data type has been modified and null values addressed, the print(data.head()) command is executed once more to showcase the revised dataset.

4.3.3 Fact Table

The Organ Donation fact table, serves as the central dataset summarizing organ donation metrics such as donors, organs procured, recipients, and transplants. It establishes direct relationships with three-dimension tables. The Ethnicity table is linked to the Organ Donation table through a many-to-one relationship based on the Year attribute, allowing the analysis of organ donation trends by ethnicity. Similarly, the Gender table connects to the Organ Donation table via many-to-one relationships on the Year and Types attributes, facilitating gender-specific insights. The Age table is also related to the Organ Donation table through a many-to-one relationship on the Year attribute, supporting the breakdown of donors and recipients by age. These relationships integrate the Organ Donation table with key demographic attributes, enabling a detailed analysis of trends over time.

4.3.4 Data Dictionary

This project employs a single dataset consisting of multiple sheets. Following comprehensive data cleaning and pre-processing, the relevant sheets have been selected to develop visualizations that align to the specified requirements and design framework.

4.3.5 Data Interpretations

Homepage is the first screen users see when they open the organ donation dashboard. It has a simple design with a clear "Get Started" button in the center. When users click this button, it takes them to the Overview Page, which is the main part of the dashboard. This makes it easy for users to start exploring information about organ donation. The design is clean and simple, helping users navigate smoothly.

Figure 6 shows the infographic page presents key facts about organ donation in a visually engaging way. It highlights important information, such as the number of people waiting for transplants and the impact of a single organ donor. The page is designed to educate and raise awareness, using bold colours, images, and text to make the message clear and easy to understand. This helps users quickly grasp the importance of organ donation and its life-saving potential.

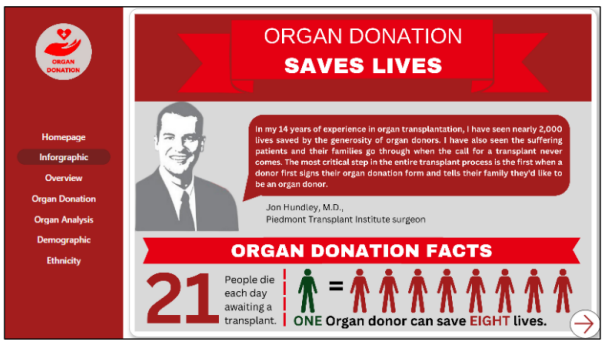

Fig. 6. Infographic Interface

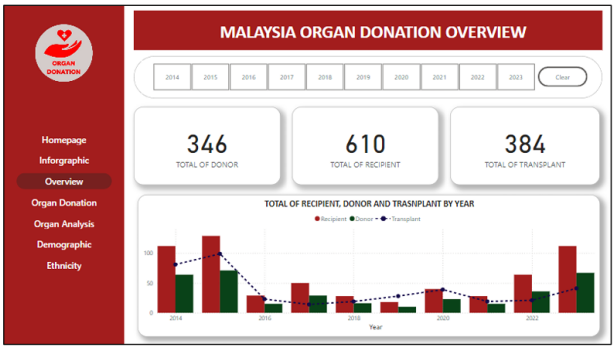

Fig. 7. Overview Interface

Figure 7 shows the Overview Page of the Malaysia Organ Donation Dashboard provides a summary of key statistics related to organ donation, recipients, and transplants over the years. The interface displays three primary metrics: the total number of donors, recipients and transplants. A timeline filter at the top allows users to view data from different years, while a graphical representation below illustrates trends in donors, recipients, and transplants over time.

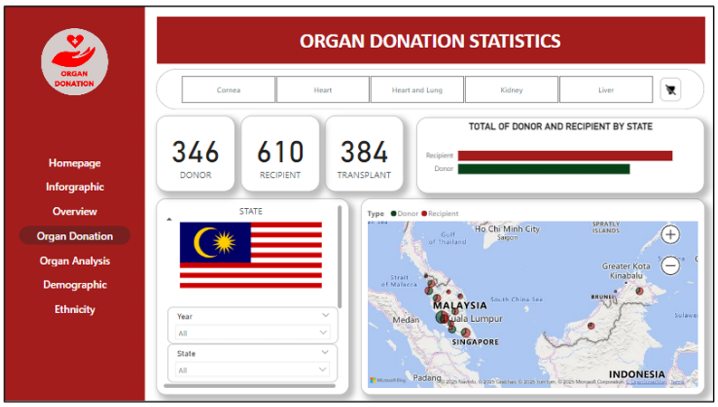

Fig. 8. Organ Donation Interface

Figure 8 shows the Organ Donation Page provides an overview of organ donation statistics, displaying the total number of donors, recipients, and transplants. It includes a map of Malaysia that visually represents the distribution of donors and recipients across different states. A bar chart compares the total number of donors and recipients by state, helping to identify regional trends. Users can filter the data by organ type and by year or state using the dropdown menu on the left.

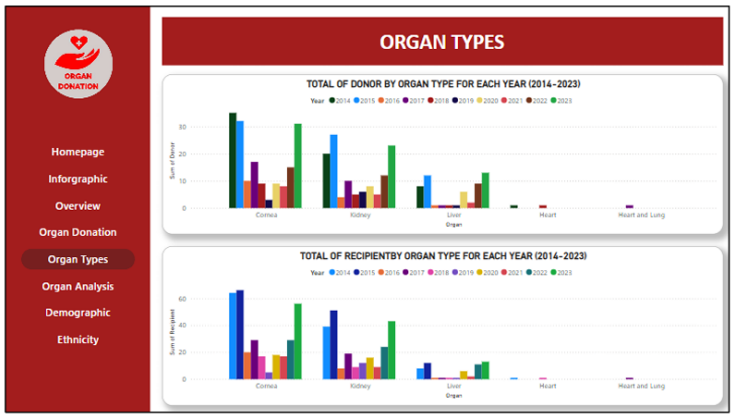

Fig. 9. Organ Types Interface

Figure 9 shows the Organ Types Page of the Malaysia Organ Donation Dashboard provides a detailed comparison of total of donor and recipient for each organ from 2014 to 2023. It features two clustered column charts, the top chart visualizes total of donor by organ type for each year while the bottom chart shows the total of recipient by organ type for each year.

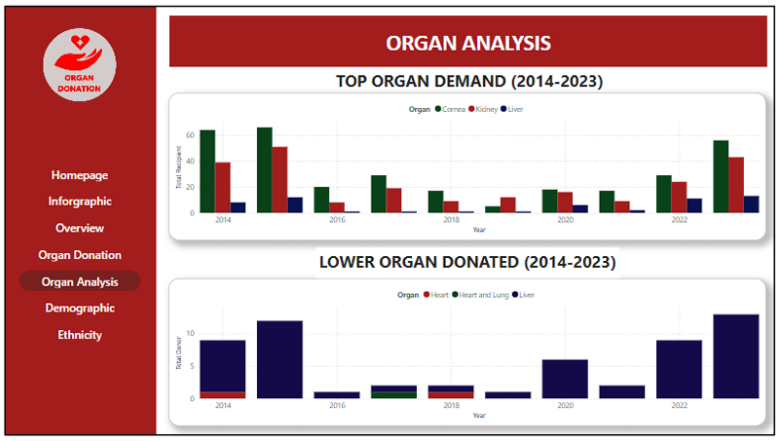

Fig. 10. Organ Analysis Interface

Figure 10 shows the Organ Analysis Page of the Malaysia Organ Donation Dashboard provides a detailed comparison of organ demand and donation trends from 2014 to 2023. It features two clustered column charts; the top chart visualizes the most in demand organs over the years while the bottom chart highlights the least donated organs.

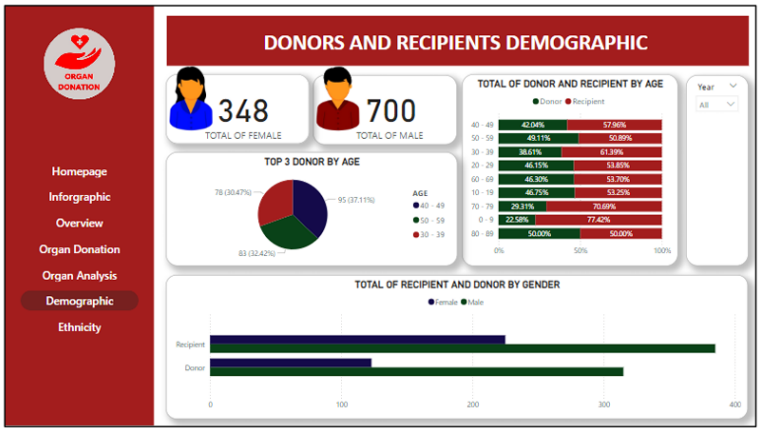

Fig. 11. Demographic Interface

Figure 11 shows the Demographic Page of the Malaysia Organ Donation Dashboard provides information on organ donors and recipients based on gender and age. It shows the total number of female and male for donors and recipients. The page includes a pie chart highlighting the most common donor age groups, a bar chart comparing the number of male and female donors and recipients, and a table displaying the percentage of donors and recipients by age. Additionally, it has filter features that allow users to sort the data based on specific years or categories, making it easier to analyze trends. This page helps users understand who is donating and receiving organs the most.

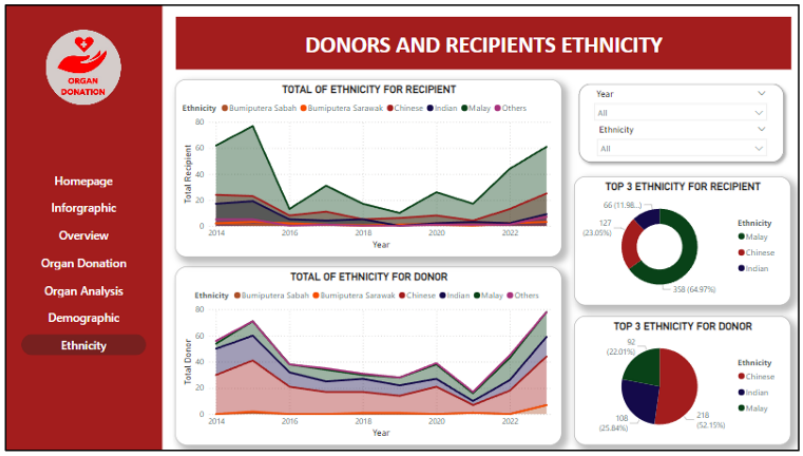

Fig. 12. Ethnicity Interface

Figure 12 shows the Ethnicity Page provides a visual analysis of the ethnic distribution of organ donors and recipients. It includes two line graphs that track trends over time, one for recipients and another for donors. Additionally, two pie charts highlight the top three ethnicities for both groups. A filter feature located on the right side that allows users to refine the data by selecting specific years and ethnic groups enabling a more detailed analysis.

4.4 System Integration

Since this dashboard system is a web-based platform, it can be accessed through a web browser and integrates with the Power BI data mart to automate visualizations within the dashboard. To illustrate this integration, a sequence diagram has been created, as shown in Figure 13 below. The figure outlines two integration scenarios. The first scenario occurs when a user accesses the dashboard system, specifically the landing page and infographic page. The second scenario involves the user applying filter features to visualizations on the overview page, organ donation page, organ analysis page, demographic page and ethnicity page.

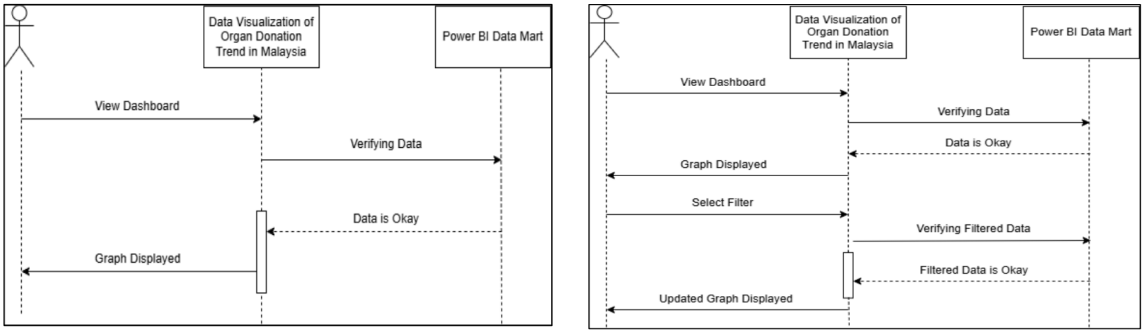

Fig. 13. Sequence Diagram of Organ Donation Trend in Malaysia dashboard

Figure 13 shows the sequence diagram illustrates the process of viewing and filtering organ donation data in a Power BI dashboard. The user first accesses the dashboard, triggering a request to the data visualization system which verifies the data with the Power BI Data Mart before displaying the initial graph. When the user applies a filter, the system again verifies the filtered data with the data mart. Once the verification is complete, the updated graph is displayed based on the selected filters. This ensures accurate and dynamic data visualization, allowing users to analyse trends effectively.

5. Conclusions

This study has achieved the objectives of the research, which are identifying the system requirements, designing, and developing data visualizations that showcase Malaysian organ donation trends from 2014 to 2023 using data from the National Transplant Resource Center (NTRC). The data visualization, especially the dashboard, is expected to play an important role in raising public awareness on the importance of organ donation in Malaysia. This research highlights that public awareness and willingness to donate are key factors influencing organ donation rates, aligning with this research's findings that limited awareness and engagement contribute to low donor registration. This study also introduces an interactive data visualization approach, offering real-time information and a more engaging method to track donation trends. With further improvements, it has the potential to become a valuable resource for governments and healthcare institutions. The dashboard will be essential to track and monitor trends in organ donation, thereby supporting efforts to increase donor registration in Malaysia and guiding policy decisions. Future research could improve on different techniques to analyse the data, as well as analyse different kinds of organ donation data to see more patterns of organ donation trends in Malaysia.

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