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DATA INSIGHT: DATA VISUALIZATION ON URBANIZATION AND MIGRATION PATTERNS OF THE MALAYSIAN POPULATION

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ABSTRACT
The demographic and economic environment of Malaysia has been impacted by two important phenomena: urbanisation and migration. The distribution of the population across the nation as well as the expansion and development of metropolitan centres have both been impacted by migratory patterns at the same time. Despite the importance of understanding the dynamics of urbanization and migration patterns in Malaysia, there is a lack of comprehensive data analysis on this topic. This research aims to design and develop an interactive dashboard that offers information related to the urbanization and migration patterns of the Malaysian population. Data analysis and data visualization for this project research were performed using Jupyter Notebook and Power BI framework. Agile methodology has been used in this research. The first objective of the research is to identify the system requirements for the data visualization on urbanization and migration patterns of the Malaysian population. The second objective is to design an interactive dashboard and the third objective is to develop an interactive dashboard of urbanization and migration patterns of the Malaysian population. The findings from the first objective are the functional and non-functional requirements of the system. The findings of the second objective are the storyboard, wireframe, flowchart and use case diagram, and the findings for the third objective are front-end development and back-end development for the data visualization. Findings from this research reveal that the factors for migration driven by economic opportunities, educational prospects, and family reunification, and business opportunities. Encouraging unrestricted access to the datasets and visualization tools can foster cooperation and additional study, leading to a more thorough comprehension of Malaysia's urbanization and migration patterns. This can benefit the data visualization industry and become applicable and effective in tackling the changing issues of urbanization and migration trends in Malaysia.

1. INTRODUCTION

Urbanization has historically been linked to human advancement and progress. However, recent research indicates that urban areas can also give rise to significant disparities and health issues (Kuddus et al., 2020). Migration, defined as the movement of a person's principal location of residence either within countries or internationally, has been a driving force behind the expansion of urban areas (Adger et al., 2020). Data visualization on urbanization and migration pattern on Malaysian population can be a valuable choice because it offers a significant amount of data to analyse, and the insights from the analysis can be used to make informed decisions. Malaysia's urban population has risen from approximately 66 percent in 2004 to 74 percent in 2014, indicating a significant upward trend in urbanization (O'Neill, 2023). Moreover, the Malaysian government provides a wealth of data on population by state, which is readily available through the Department of Statistics Malaysia. This data Department of Statistics Malaysia. This data can be used to analyse a wide range of demographic factors, such as year, state or country, sex, and the number of populations.

Analysing and interpreting dataset enable students to obtain important proficiencies in data analysis and visualization, while also enhancing our comprehension of Malaysia's populace patterns. Furthermore, the outcomes of the analysis may be employed to guide policymaking concerning population management, urban development, and growth in Malaysia. It is essential for policy makers, academics, and other interested parties to gain an understanding of the changes in urbanization and migratory patterns to make sound decisions regarding sustainable urbanization, the allocation of resources, and the provision of social services. Visualization of data is a key factor in conveying complex information in a visually appealing manner, allowing for the extraction of pertinent information and the implementation of evidence-based decisions (Vázquez-Ingelmo et al., 2024). However, it is difficult due to a lack of useful data visualization tools and a clear visual depiction of urbanization and migration data. Despite the importance of understanding the dynamics of urbanization and migration patterns in Malaysia, there is a lack of comprehensive data analysis on this topic (Migration Data Portal, 2022). These restrictions make it difficult for decision-makers in government, academia, and local government to achieve sustainable, balanced development that keeps pace with modern technology developments.

Thus, this research aims to design and develop interactive dashboard that offers information related to urbanization and migration patterns on Malaysian population. The objectives of this research are to identify system requirements for data visualization on urbanization and migration patterns on Malaysian population, to design an interactive dashboard that display about urbanization and migration patterns on Malaysian population and to develop an interactive dashboard of urbanization and migration patterns on Malaysian population.

The scope of this research is a migration population's dataset in Malaysia. This data visualization project aims to contribute to the broader goal of achieving Sustainable Development Goal 3 (Good Health and Well-being) and support evidence-based policymaking to ensure the well-being and prosperity of the Malaysian population in the context of urbanization and migration.

2. LITERATURE REVIEW
2.1 Big data
Big data can be defined as a giant size of data (Baig et al., 2019). Big data gathers information from various sources, both traditional and digital, within and beyond an organization, to enable continuous exploration and investigation (Arthur, 2013). According to Tosi et al. (2024), big data has large quantities of dissimilar data which allows processing in real time analysis and response.

2.2 Characteristics of big data
Big data is defined by five features, or the "5Vs," which stand for Volume, Variety, Velocity, Veracity, and Value (Hadi et al., 2015).

2.3 Type of data visualization
The following are some of the most common forms of data visualization such as bar graphs, pie charts, infographics, tables, heat maps and scatter plots.

2.4 Data visualization tools
There are a few tools for data visualization. R and Python programming are required for creating visualization charts and graphics. According to Arockia et al. (2017) the data visualization tools suggested are Data Wrapper, Dygraphs, Chart JS, Tableau, Plotly, Python Jupyter, Power BI and others.

2.5 Dashboard development process
Dashboard development process can be simplified into 4 phases 'Define', 'Prototype', 'Build' and 'Deploy' (Kobi, 2024). The stakeholders are identified and the decisions they must make are understood before the dashboard design process can begin. Next, choose the metrics that will support those choices. Designers then gather feedback, iterate, and create paper sketches of dashboards. Researchers must find the actual data and build the dashboard after making sure the prototype fits the project's goals. For the audience to use the dashboard, designers must disseminate and maintain it.

2.6 Factors of urbanization in Malaysia
The city's growth has been influenced by all the accessible causes at different points in history. This period starts when those factors start to become more intense, which is around the middle of the eighteenth century. Rapid changes in these variables, typified by urbanization and industrialization, have in a sense produced what is broadly referred to be modern society (Hussain et al., 2018). The primary cause of the urbanization trend can be attributed to the agricultural revolution. The technological revolution is the second main driver of urbanization. The creation of the factory system, mass manufacturing techniques, and the steam engine allowed the population to gather in a densely populated design. The next factor behind urbanization is the commercial revolution. World markets, exchange networks, and significantly better modes of transportation and communication all contributed to the creation of cities in areas where they otherwise would not have been possible.

2.7 Factors of international migration
The recent rapid growth of Malaysia's economy has resulted in a great need for labour across several industries, such as construction, manufacturing, and services. Migrant

labourers from Bangladesh and Indonesia, two neighbouring nations, have been driven to this by the possibility of greater job prospects and higher earnings. The International Organization for Migration (IOM) estimates that in Malaysia in 2022, there would be more than 2.2 million migrant workers. Most of these individuals are engaged in low-skilled occupations like industrial, construction, and domestic helper employment.

Malaysia is a popular destination for international students due to its diverse population, affordable cost of living, and high standard of education. After graduating, a lot of overseas students decide to work or continue their education in Malaysia. A common reason for migration to Malaysia is to join or reunite with already-residing family members. This plays a significant role in both international and domestic migration, even inside Malaysia. For 46.5% of internal migrants in 2020, the Department of Statistics Malaysia reports that family reunification was their main motivation for migrating. In 2020, it accounted for 21.6% of all immigrants and was the second most frequent cause of migrating abroad.

2.8 Factors of internal migration

According to Lim (1996), the factors for Malaysian migration among Malaysians include economic reasons, lack of meritocracy, business opportunities, education opportunities for example is study abroad, family reasons, most common with recent immigrants or permanent residents, marriage to a foreigner with a job in the foreign country, and institutional racism. Rapid industrialization, stable growth, and rapid educational improvements are critical factors that attract foreign workers to Malaysia (Del Carpio et al., 2013). Furthermore, the perception of Malaysia's migration governance system, labour migration dynamics, and policy reversals has also been identified as influential in shaping internal migration patterns (Foley, 2023).

2.9 Existing dashboard

The existing dashboard from Department of Statistics Malaysia (DOSM) shows the selected statistics of migration by years as shown in Figure 1. This dashboard shows from total of population in Malaysia to people of be the migrants and non-migrants as well displays the reason for internal migration. reason for internal migration. The dashboard provides a valuable overview of the migration patterns in Malaysia which can be used to understand the trends and drivers of migration, as well as to develop policies and programs to support migrants and their communities.
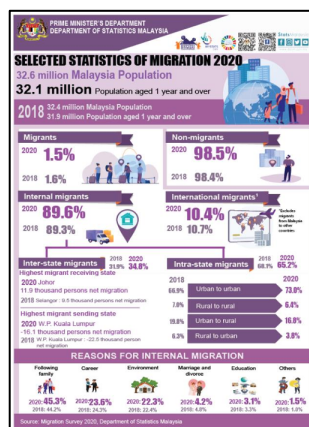

Figure 1: Existing dashboard DOSM

2.10 Agile methodology

Agile methodology is a method of software development and project management that emphasizes the iterative and collaborative nature of the process. It emphasizes flexibility, adaptability, and customer satisfaction. Agile methodology was developed as an alternative to traditional linear project management methods, which were unable to adapt to changing requirements and did not involve customers in the development process. Other than that, since the research has a time limitation of only six months, the Agile methodology also suits this research as compared to other methodologies.

In summary, the Agile framework can be applied to data visualization on urbanization and migration patterns in the Malaysian population by integrating stakeholder collaboration, small iterative projects, and the use of specific Agile frameworks with the relevant tools and technologies, such as GIS and remote sensing, to support adaptive learning and timely insights.

2.11 Data science lifecycle frameworks

OSEMN refers to a specific process within the data science workflow that focuses on the steps for data manipulation and analysis. OSEMN stands for 'Obtain', 'Scrub', 'Explore', 'Model', and 'Interpret'. It is a way of looking at data that is used a lot in data science. Basically, it helps analysts and data scientists understand how to work with data in different ways so they can make better decisions. In the context of urbanization and migration patterns in Malaysia, the OSEMN framework can be integrated with GIS tools and remote sensing technologies to support data visualization and analysis (Tedong et al., 2018). This will enable the generation of easy-to-understand and actionable insights for policymakers and stakeholders, helping them make informed decisions on urban planning and migration management.

3. RESEARCH METHODOLOGY

This research uses the Agile methodology framework throughout project development process as it is the most suitable methodology framework for data visualization project. While OSEMN framework is used to work specific process within the data science workflow that focuses on the steps for data manipulation and analysis. The main objective of this phase is to clearly define the project requirements, thus gaining a better understanding of the project's context. This includes identifying the necessary tasks to achieve the project's goals.

There are three objectives in this research. Table 1 below shows the phases, techniques and deliverables of the three objectives of this research.

Table 1: Objectives and deliverables of the research

Objectives	Phases	Activities	Tools/ Techniques	Deliverables
To identify the system requirements of data visualization on urbanization and migration patterns on Malaysian population	Requirement	Define problems	Techniques: Literature Review Tools: Lists of websites, Science Direct, Online Database	Problem Statement
		Ideate solution	Techniques: Literature Review Tools: Lists of websites, Science	Project objectives Project scopes Lists of hardware and software

		Data extraction	Direct, Online Database Techniques: Obtaining data from DOSM.	Datasets for development of data visualization on urbanization and migration pattern on Malaysian population
To design an interactive dashboard that display about urbanization and migration patterns on Malaysian population	Design	Data transformation	Techniques: Data cleaning, data processing Tools: Python	Cleaned datasets for system development
		Dashboard design	Techniques: Storyboard Tools: Power BI	Dashboard layout and illustration of data
		System functions	Techniques: Requirement Analysis	Lists of functional and non-functional requirement
		Database design	Techniques: Conceptual database design Tools: draw.io	System database architecture
To develop an interactive dashboard of urbanization and migration patterns on Malaysian population	Development	Data load	Techniques: Data interpretation Tools: Python	Data store
		Dashboard development	Techniques: Data visualization Tools: Python	Dashboard system
		System testing	Techniques: Integration checking	
	Testing	Usability testing	Techniques: SUS Tools	System feedback

In summary, both the Agile methodology and the OSEMN framework provide useful ways in this respective fields. For data science initiatives, OSEMN offers an organized framework that leads practitioners through the critical processes of gathering, preparing, analysing, and interpreting data.

4. RESULTS AND DISCUSSION
4.1 Objective 1: identification of data and system requirements
Data requirements involve the systematic identification, prioritization, precise formulation, and validation of data needed to meet business objectives.

4.1.1 System requirement
Table 2 and Table 3 show both the functional and non-functional requirements essential for the Data visualization on urbanization and migration patterns of the Malaysian population. Table 4 and Table 5 on the other hand show the hardware and software requirements.

a. Functional and Non-Functional Requirements

Table 2: List of functional requirements

Functional Requirement	Description
Dynamic Visualization	Users can observe the data directly from the dashboard.
Visualization on Dashboard	User interaction with the visualization is encouraged instead of merely observing the dashboard.
Filtering of Data	Users can filter and search data, enabling the display of graphs based on the data through the implementation of the drill-down method.

Table 3: List of non-functional requirements

Non-Functional Requirement	Description
Accessibility	The system is accessible across various devices, including desktop computers, tablets, and mobile phones.
Usability	The dashboard is designed for user-friendliness, featuring an easily navigable interface with intuitive buttons for seamless interaction.
Performance	The efficiency is measured by the time it takes for an average user to find necessary data and gain insights from the visualization. Additionally, the overall user experience is enhanced by minimizing the total number of clicks required.

b. Components of Information Technology Infrastructure in Systems

Table 4: List of hardware

Hardware	Purpose	Specification	
Laptop	To run web based dashboard visualization	Processor	Intel(R) Core(TM) i5 10210U CPU @ 1.60GHz 2.11 GHz
		RAM	12.0 GB
		Storage	512 GB
		Operating System	Window 11 64-bit
		Graphic Card	NVIDIA GeForce MX230 Intel® UHD Graphics

For the software, according to previous research, they applied the Python Jupyter Notebook to implement a literate programming paradigm. The goal of the Jupyter is to create a computational narrative by combining human language and live code and its results into a single narrative. Power BI is a great business analysis tool that could provide quick analysis for choice via its desktop software by modelling data and visualising it.

Table 5: List of software

No	Software	Description
1	Operating System	Window 11 64-bit
2	Power Bi	To visualize the dataset
3	Anaconda Jupyter Notebook	To perform data cleaning
4	Python Language	Programming language to perform data cleaning
5	Draw.io	To draw use case diagrams and flowcharts.
6	Canva	To illustrate a storyboard

4.2 Objective 2: designing urbanization and migration dashboard
The design process comprises several stages, including comprehension, research, sketching, design, prototyping, and testing. 29 iterations in the design process commence at the initial stage and persist through to the final stage.

4.2.1 Storyboard
A storyboard is a set of visual representations depicting a sequence of screens. It serves as a graphical depiction of the scene and serves as a tool for arranging the chronological sequence of actions related to the primary issues driving the development of this project as depicted in Figure 2.
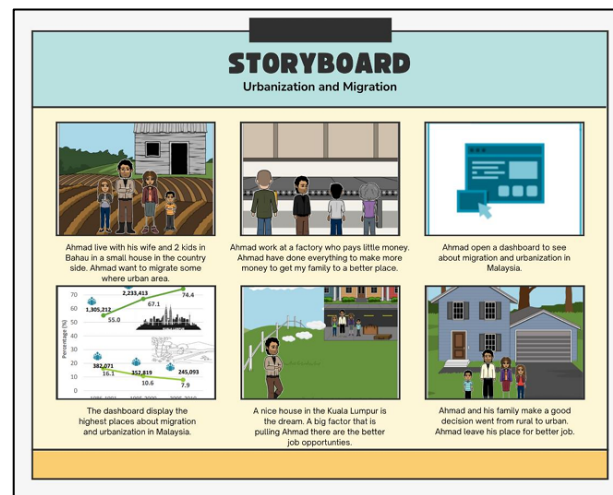
Figure 2: Storyboard

4.2.2 High fidelity of data visualization on urbanization and migration patterns on Malaysian population
Figure 3 displays a wireframe with a simple graphic depiction that shows the organization and design of a webpage or application. It functions as a kind of basic framework to show where important components and features should be placed.
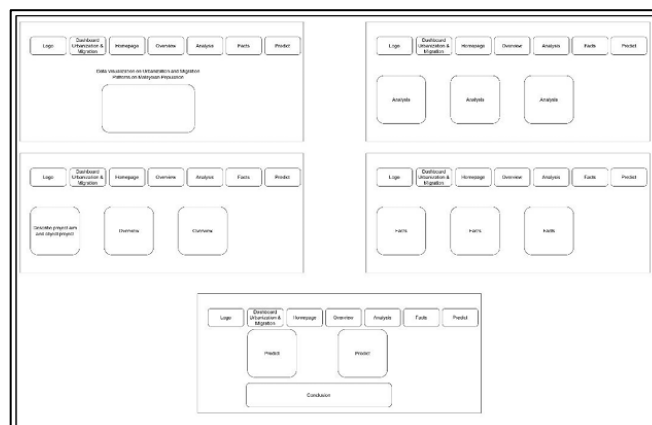

Figure 3: Wireframe

4.2.3 Urbanization and migration dashboard flowchart
The dashboard on urbanization and migration a flowchart is a graphic that illustrates the entire process of planning, creating, and using a dashboard to show information on migration and urbanization in the Malaysian population as in Figure 4.
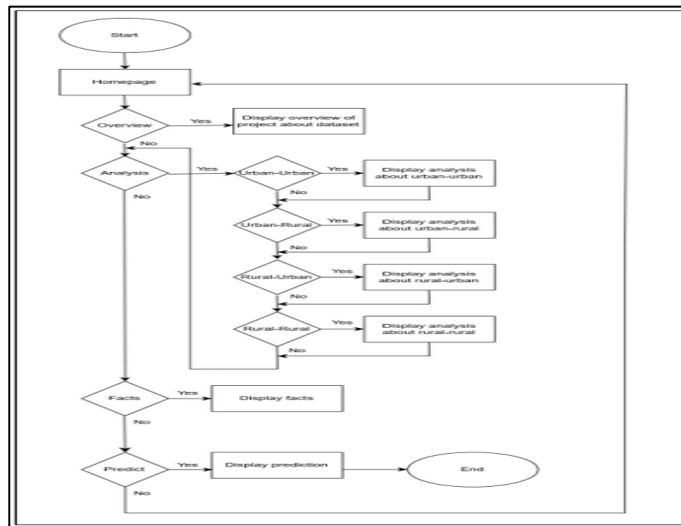
Figure 4: Flowchart

Flowchart design is necessary for any system or website development to determine the system's flow. The different symbols in this project are meant to symbolize the dashboard's flow.

4.2.4 Urbanization and migration use case diagram
A use case diagram showcases system functions and user centric system needs by visually representing a group of use cases, actors, and their relationships. Use cases outline the series of operations, including modifications, that the system does to provide an actor with appreciable value. A use case diagram was created using the Draw.io program in relation to the Urbanization and Migration Dashboard as in Figure 5.
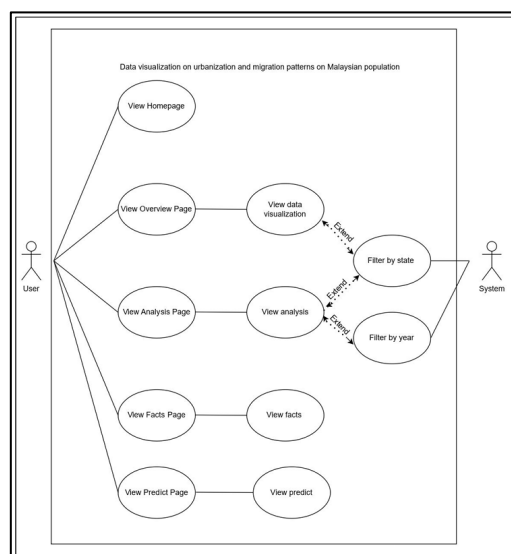
Figure 5: Use case diagram

Table 6: Urbanization and migration use case summary

Actor	Action	Description
User	View homepage	The main page of this project is available to the public, where they can read about its goals and purposes. Users can click the facts, overview, and analysis buttons to move on to the next page.
	View overview page	The analysis overview of migrants generated from the dataset displayed on this page is available for viewing by users. If they want a more specialized visualization, they can use filters to concentrate on a certain state. Furthermore, viewers can obtain comprehensive details on each component of the graph by hovering over it.
	View analysis page	Keyword analysis, covering categories like urban-urban, urban-rural, rural-urban, and rural-rural, is available for users to explore. Hovering over information about cities in tables and charts allows users to see more details about the graph. Additionally, they can use filters to concentrate on a particular state for a keyword-based customized display.
	View facts page	This page provides information on the causes of people's migrations between states. The main factor influencing people's decision to migrate is visible to users.
	View predict page	This page show the prediction forecast for internal and international migrants by year.
	Filter by state	The system has the capability to apply a filter to the visualization depending on the state.
System	Filter by year	There are four urbanization types, namely urban-urban, urban-rural, rural-urban, and rural-rural. Users have the option to select a specific type of urbanization for analysis, showcasing migrants in a particular area associated with that specific urbanization category.

4.3 Objective 3: developing urbanization and migration dashboard

This part discussed the third objective and present the prototype's results.

4.3.1 Front end development

User interfaces (UI) are the areas where designs and users interact. A particular format used in user interfaces is called a graphical user interface (GUI). Users interact with visualizations on control panels while using graphical user interfaces (GUIs). Figures 6 and 7 show the dashboard's displays for "Homepage" and "Overview".
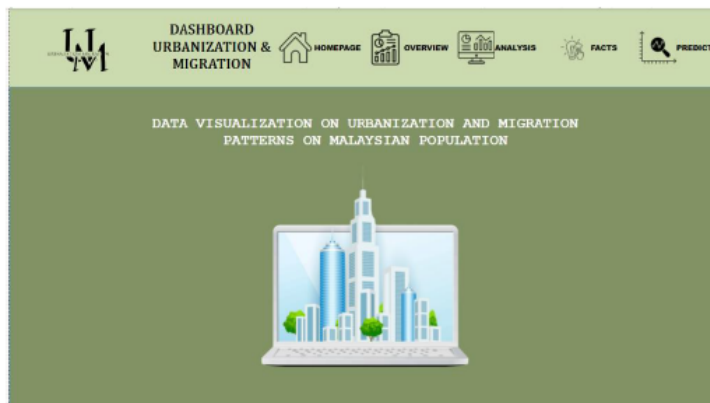

Figure 6: Homepage

This figure displays the dashboard's home page for migration and urbanization. The buttons on the dashboard are labelled "Homepage," "Overview," "Analysis," "Facts," and "Predict." This dashboard is a research and analysis tool for migration and urbanization trends.

Figure 7: Overview

The number of total internal and international migrants is the overall dataset that display the internal and international migrants. The map shows the state based on the number of internal and international of migrants. Graph bar shows the total of internal and international by year from 2018 to 2022. The filter above is to click any state to see the internal and international migrants.

4.3.2 Back end development

This section explains how the dashboard's visualization is displayed by the front-end interface processing all the data. The preparation and loading of the data layers into the data portal linked to this dashboard is also covered in this section.

The method for data cleaning involves removing incomplete data from a dataset and trying to replace any incorrect, corrupted, or data in the wrong format. Pandas is a Python program used to read data from many sources. To load the package, type "import pandas as pd." The initial stage in data cleaning involves importing data into Python, and this can be done using either Excel or CSV formats. The read_csv function is utilized to read data from a CSV file in Python. For Excel data, the read_excel function is employed to facilitate its import into Python.

The df_info function, often a shorthand for DataFrame information, is a valuable method in the Pandas library within Python for gaining insights into the structure and characteristics of a DataFrame. When applied to a Pandas DataFrame, df_info provides a comprehensive summary that includes details such as the number of non-null values, data types of each column, and memory usage. The missing value in each column of the dataset is also being treated.

The is null function is used to display the null value in each row. This function is used to show the exact row that have a null value and will be display as True. The row will be display False if the data is not null in the dataset. The defaultInt function is used to set the default value for integer value. The defaultSring function is use for set default value to string data and defaultfloat is use to set default value for float value

in datasets. All of these functions is important to make all of the data in dataset not have a null value.
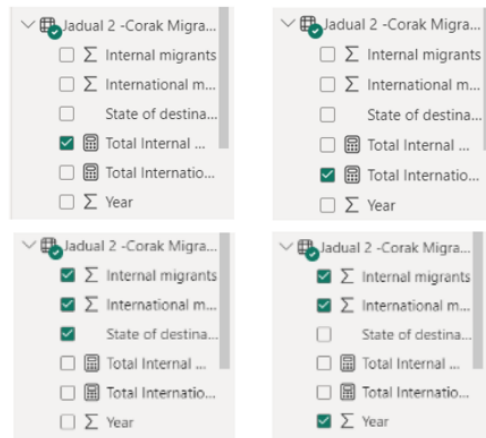

Figure 8: Overview back end

Figure 8, shows how the overview page dashboard is created. The dashboard displays the total of internal and international migrants and the map graph shows based on state.
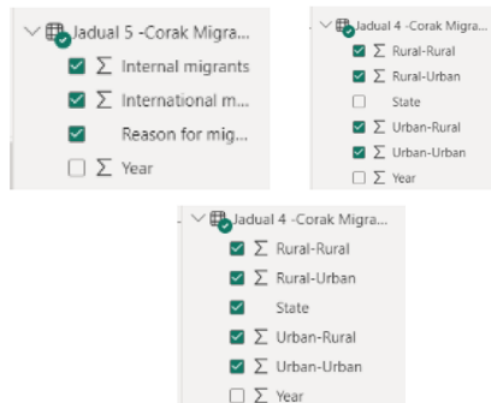

Figure 9: Analysis back end

Figure 9 shows how the analysis dashboard page is created. The dashboard displays the reasons for migration, the type of migrants such as urban-rural, rural-urban, urban-urban, and rural-rural.

4.3.3 System testing
User testing is a technique used in software development, product design, and other industries to assess a product's usability by seeing how representative users interact with it.

There are ten respondents participated in the research. 90% of the respondents are from age group of 19-25 years old while 10% from age group of 26-35 years old. 70 % of the respondents are male while 30% of them are female. 90% of the respondents are degree holder while 10% of them are "Matriculation/STPM" level.
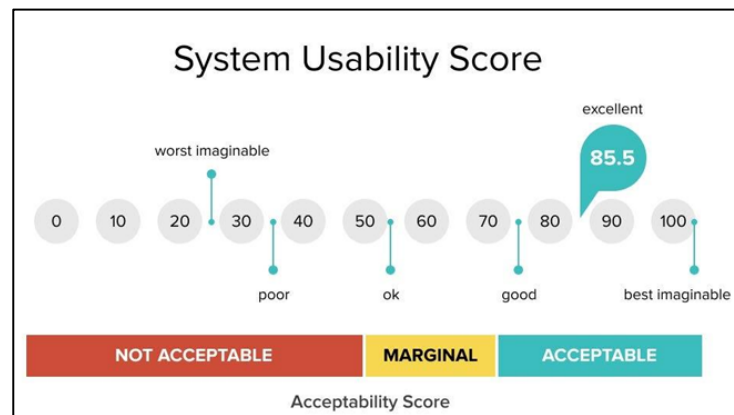
Figure 10: System usability score

Table 7 shows the system received moderate to good SUS scores from the respondents. The average final score of 60.75 falls within the range of "marginal" usability according to the Smyk (2021) interpretation of SUS scores. However, it is important to note that the size of the sample (10 respondents) is relatively small, so the results may not be generalizable to a larger population. This is due to the time limitation for the research. Future research can help in providing more respondents for the testing phase.

Table 7: System usability score by respondent

Respondents	SUS Raw Score (X+Y)	SUS Final Score (X+Y) x 2.5
1	22	55
2	24	60
3	24	60
4	22	55
5	26	65
6	24	60
7	22	55
8	24	60
9	25	62.5
10	30	72
Average	**24.3**	**60.75**

In summary, the examination of the requirements aligns with the description of the Data Visualization on Urbanization and Migration Patterns in the Malaysian Population. The survey of the requirements corresponds to the outlined specifications for the created Data Visualization on Urbanization and Migration Patterns in Malaysia. Additionally, a survey was conducted among the public to acquire essential criteria for the project. The input from the specifications review influenced the project's design phase, commencing with the storyboard and concluding with a fully functional model.

5. CONCLUSION
In summary, all of the three objectives of this research have been achieved. Research into data visualization on migration and urbanization trends among Malaysians has shed light on Malaysia's dynamic socioeconomic environment. This research can successfully match the research objectives and produce a realistic portrayal of

migration trends and demographic transitions. Public surveys improved the project's base by considering a variety of viewpoints and standards that are essential for reliable data representation.

It is recommended for future works to establish partnerships with pertinent governmental bodies, academic establishments, and global associations can facilitate the acquisition of varied datasets, thereby augmenting the visualization with an expanded range of data to guarantee the availability of thorough and current information, ongoing efforts in data gathering and updating. Moreover, encouraging a culture of data literacy through instructional programs can enable users to make efficient use of and interpretations of the visualizations. To conclude, encouraging unrestricted access to the datasets and visualization tools can foster cooperation and additional research, leading to a more thorough comprehension of Malaysia's urbanization and migration patterns.

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