Exploring Alumni Data using Data Visualization Techniques

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Abstract—**Alumni data are mostly managed through paper-based and word file. With lots of alumni graduating each year, these massive data become difficult to handle. It is hard to look for past alumni data to know their current situation. Since the data is kept conventionally, there is no communication between the alumni and the faculty. Therefore, we proposed a solution that includes alumni information regarding their status in life where alumni themselves and individuals in the faculty can see. This study aims to visualize alumni data from a faculty in a public university through an exploratory dashboard using the identified data visualization techniques. This study adopts the dashboard development process consists of three major phases, which are conception, visualization, and finalization phase. The primary audience is identified and the theme for the dashboard is decided in the conceptual phase. The primary and support views are then designed together with the layout during the visualization phase. At the end of the study, the exploratory dashboard for alumni data using multidimensional and hierarchical data visualization is finalized with the interactive elements. The results are interpreted through descriptive and diagnostic analysis. The dashboard is then evaluated through convenience sampling technique to verify the representation of the dashboard. Majority respondents agreed on the simplicity of exploratory dashboard and the amount of data is also sufficient with the selection of the visualization types. The dashboard is beneficial to the university's administrator, alumni, and public.**

Keywords—Alumni; descriptive analysis; diagnostic analysis; data visualization; exploratory dashboard

I. INTRODUCTION

Alumni is classified as a significant secondary source of revenue [1]. Alumni are one of the important resources for the university. They are the individuals who symbolize the university within the world. Numerous alumni networks were at first began from regional groups of alumni united for university fundraising activities. These associations gradually obtained an added significance within the evolution of the university due to their tremendous advocacy capability that assists the university and prepares students in their future profession.

By connecting with alumni, a university can keep on profiting from their abilities and knowledge. Alumni management is straightforwardly related to the amplification impact of alumni resources in this technology era. The issue is that the conventional alumni data management system is hard to adjust to the large alumni groups and the massive amount of data [2]. The current method used by the university in managing alumni data is through the traditional way where the alumni management staff is maintaining paper-based documents to store the information, for example, alumni and college details.

Thus, it is hard to sustain the past information and important data through a paper-based method. Staffs require more time to create required alumni reports. It is dreary to administer past information, which requires much room to store every one of the past year's records and documents paperwork. For example, Universiti Teknologi MARA is among the public university in Malaysia and has branches in every state in the country. Thus, they have a lot of alumni every year and without data visualization, it will be hard to trace the alumni current situation or where they are going after they finish their study.

There are several universities in Malaysia that embodied data visualization in their systems for alumni, but the visualization is limited to certain criteria. This paper proposes an alumni data visualization through an exploratory dashboard using identified data visualization techniques. This study uses the data from alumni of the Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Malaysia. The data are the alumni general academic program data and employment data, without containing any personal information. These alumni data are visualized using multidimensional and hierarchical data visualization.

The paper consists of five sections. It starts with Section I Introduction; continues with Section II Related Works. It follows by Section III Methodology to report on the methods used in this study. Then, Section IV includes the results and discussion, and the last section concludes the study.

II. RELATED WORKS

A. Data Visualization

Data visualization is the act of presenting data or information into a pictorial or graphical context, such as a chart, a map, or other visual formats, to make information uncomplicated for the human brain to comprehend and understand [3].

Data visualization is a sector that corporates data from numerous fields, for example, psychology which examines the data insight and the effect of certain components on data insight, next is the computer science and statistics field which expanded ideas in the new area like artificial intelligence and

data mining methods [4]. The visual and multimedia design field is also crucial to assembling infographic dashboards which involve a few elements including data, scales, lines, bars, and colored shaped sizes.

B. Types of Data Visualization

Some of most popular data visualization types are temporal, hierarchical, network, multidimensional, and geospatial data visualization. These data visualization types have different criteria and strengths in representing the alumni data.

1) Temporal Data Visualization: Data that have progressive values significant and recorded. Temporal visualizations usually include lines that either remains solitary or overlap with one another, with a beginning and end time [5]. Examples of temporal data visualization are scattered plots, line graphs, and polar area diagrams. This type of data visualization can represent the changes of data in timeline form. The parameters used in the alumni visualization are not suitable for temporal data visualization because there are no data on time-related. Thus, this study does not use the temporal data visualization.

2) Hierarchical Data Visualization: Information that can be organized as a tree [6]. The connection between the parent nodes and the child nodes forms a tree network. It shows how information was positioned and arranged together in a system [7]. Examples of hierarchical data visualization are treemap charts, tree diagrams, and sunburst diagrams. This type of data visualization can be used in data consisting of main categories and sub-categories. This study use a treemap chart to visualize alumni job category based on their domain.

3) Network Data Visualization: A set of nodes with links interfacing with the nodes [8]. Nodes stand for data points, and links represent the associations between them [9].

Examples of network data visualization are matrix charts, node-link diagrams, and word clouds. This data visualization is widely used on social media platforms such as Twitter and Instagram. Since the alumni data in this study has no relationship between parameters, network data visualization is not suitable to be used as the alumni data do not involve any associations among the dataset.

4) Multidimensional Data Visualization: It analyzes various data dimensions or qualities [10]. Multidimensional data visualization includes simply looking at distributions and possible connections, patterns, and relationships among these qualities. Examples of multidimensional data visualization are bar charts, Venn diagrams, and pie charts. Among all the five types of data visualization, multidimensional is commonly used for the dataset because the alumni data consists of many parameters that are suitable for multidimensional as it allows representation of multiple categories in the dataset.

5) Geospatial Data Visualization: It is the earliest type of data visualization [11]. Geospatial data visualization covers factors on a map using latitude and longitude to encourage understanding. Examples of geospatial data visualization are choropleth maps, cartograms, and heat maps. This data visualization is used for data that has locations and involve the use of the map. In alumni data visualization, choropleth is suitable to visualize alumni location because it uses values on a specific region on the map. However, we exclude this location information due to the privacy issue.

From Table I, two types of data visualization are more suitable to represent the relationship between alumni datasets in this study. Multidimensional data visualization and hierarchical data visualization can visualize multiple data variables such as alumni general data and alumni employment data, and it is easier to interpret the data and extract the information from the data.

TABLE I.   Comparison of Data Visualization

Characteristic	Types of Data Visualization				
	Temporal	*Hierarchical*	*Network*	*Multidimensional*	*Geospatial*
Type of data	Time series, the event sequences	Data which have main category and sub-category	Relationship between nodes and links	Multiple data parameters and categories	Data involving geographical location
Usage	Use in climate data, and historical presentation	Use in politics, mathematics, or organizations	Use in social media platform	Use in medicine and social sciences	Use in Google maps, and weather maps
Technique	Scatter plot, Line graph, Polar Area, Time Series	Tree Diagram, Sunburst Diagram, Tree Map Chart, Circle Packing	Matrix Chart, Node-Link Diagram, WordCloud, Sankey Diagram	Stacked Bar Chart, Pie Chart, Venn Diagram, Histogram	Choropleth Map, Density Map, Cartogram, Heat Map
Justification for the usage of data visualization in the proposed alumni data visualization	The parameters use in the alumni visualization is not suitable for temporal data visualization because there are no time-related data.	Can be used in data consists of main category and sub-category. This study uses treemap chart to visualize alumni job category based on their domain	*The alumni data used in this study are simple data, network data visualization is not suitable to be used as the alumni data do not involve any associations among the datasets.*	Multidimensional is commonly used because the alumni data consists of parameters that allows representation of multiple categories in the dataset.	The alumni data used in this study is not suitable for geospatial data visualization because there are no data on alumni state of origin.

C. Alumni Data Visualization

This section focuses on analyzing five existing alumni data visualization models from foreign and Malaysia local universities.

1) Graduate Alumni Salaries – University of Colorado Boulder: It develops a data visualization for its alumni based on their salaries as shown in Fig. 1. This university used multidimensional, geospatial and hierarchical data visualizations [12]. The multidimensional data visualization is horizontal bar charts to visualize the alumni salaries, the job category and the employer category. The geospatial data visualization is a choropleth map to show the employer location by state. A treemap, which is a hierarchical data visualization, shows the top industries category where it displays categories similar to each other and any correlations between them. This data visualization has a filter feature to enable the user to search data based on specific keywords. This data visualization do*es* not use temporal and network data visualization as it do*es* not have any parameters that *are* suitable for that type of data visualization. This data visualization uses three *colors,* which are chocolate, grey and black. The use of three *colors* give *a* simpler and neat look. The visualization do*es* not look crowded and messy.

2) Mapping Institutes of Fine Arts (IFA), New York University Alumni: It develops a data visualization for their alumni, which shows the current employment status of their active alumni as shown in Fig. 2 and Fig. 3 [13]. This institute uses network and multidimensional data visualizations. The network data visualization used is a network map that shows the current employment location of alumni where it shows how the different location is interconnected from one node to other nodes through link lines. The multidimensional data visualization used is a vertical bar chart to visualize the type of employment of the alumni. In this data visualization, several colors are used to represent the employment categories and display them in the bar graph. This data visualization does not use geospatial, temporal or hierarchical data visualization because the dataset involved is not related to this type of data visualization. This data visualization also uses a filter feature to enable the user to search alumni data based on institutes and people.

3) Alumni of Universiti Malaysia Sarawak: The university developed a data visualization for their alumni, which shows the number of alumni graduates from each faculty from 2006 to 2015 [14]. This data visualization used multidimensional data visualization and display data insight for the website visitor as shown in Fig. 4. The university used a stacked bar graph to show the trend of alumni graduates based on their level of study. This data visualization does not use an interactive dashboard. Thus, the visitor can only view the website for the alumni data and they cannot interact with the data. This data visualization only uses multidimensional. Thus, the presentation of data is not complete as it only visualizes the number of alumni who graduated. The alumni visualization developed in this research study can enhance this

issue by implementing the interactive dashboard for the alumni and incorporating other types of visualization to represent different types of alumni data.
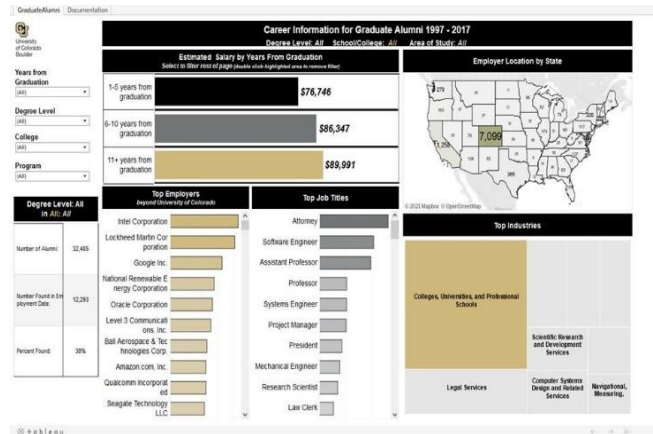

Fig. 1.   Data Visualization for Graduate Alumni Salaries.

Fig. 2.   Network Data Visualization for Institutes of Fine Arts.

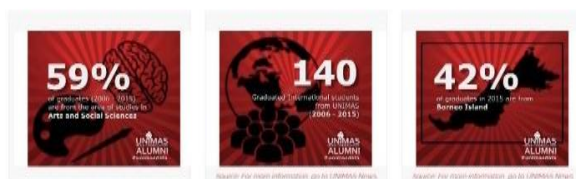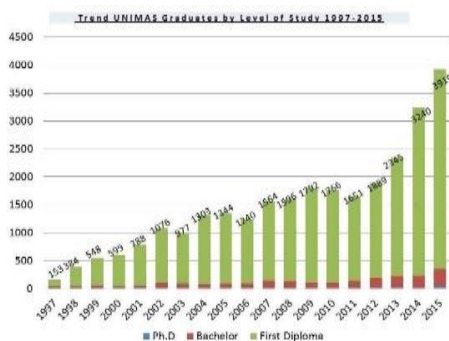Fig. 3.   Multidimensional Data Visualization for Institutes of Fine Arts.

Fig. 4. Data Visualization for Universiti Malaysia Sarawak Alumni.

4) Alumni of Universiti Islam Antarabangsa Malaysia: The univeristy has developed a data visualization for its alumni, which shows the total numbers of local and international alumni [15]. This interactive data visualization used geospatial data visualization to display the number of alumni based on the country of origin as shown in Fig. 5. It used a choropleth map to visualize the geographical area where it will display the number of alumni based on the state. The university does not use an interactive dashboard for their data visualization as they only implement visualization for alumni state. The visitor can hover over the map and the number of alumni is displayed for the country chosen. Since this data visualization only uses geospatial, a lot of alumni data are not shown and the visualization looks simple. The visualization can be enhanced by including more types of data visualization so that more alumni data can be visualized to user.

5) Alumni Data of Heritage College of Osteopathic Medicine, Ohio University: The university developed a data visualization for their alumni, displaying the percentage of alumni practising area and specialization [16]. This interactive data visualization used multidimensional and hierarchical data visualization to visualize the alumni data as shown in Fig. 6 and Fig. 7. A multidimensional data visualization used in this system is the pie charts to show the percentage of alumni practicing and training areas in the primary and non-primary sectors. While the hierarchical data visualization used is a treemap chart to show the number of alumni based on their specialization. In the pie chart, several colors are used to represent the keyword for the alumni practicing sectors. The pie chart has also been divided into four sections with four different colors to enable the user to see the data explicitly and differentiate it. The treemap chart also been divided into four different colors to indicate the different categories for the alumni specialization. This research study will include these

two types of data visualization in order to visualize the alumni general data and alumni occupation data.

From Table II, the existing data visualization developed by the University of Colorado Boulder shows the best data visualization method and suitable to be adopted in this study. This is because the data visualization used by the university is multidimensional data visualization, hierarchical data visualization and geospatial data visualization. In this study, we adopt this technique to visualize alumni general data and alumni employment data.

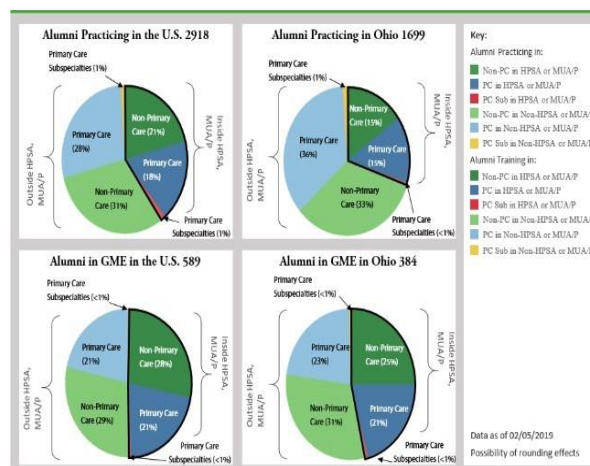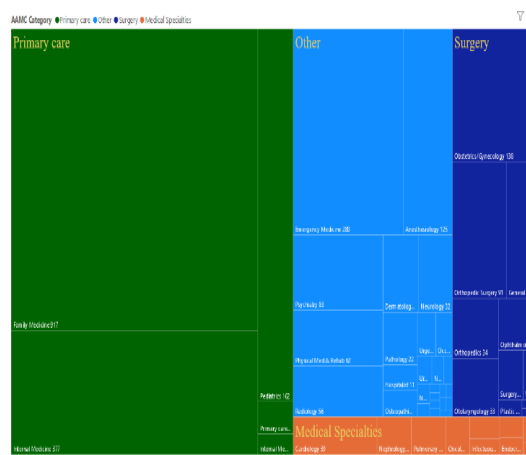Fig. 5. Data Visualization for Universiti Islam Antarabangsa Malaysia Alumni.

Fig. 6. Multidimensional Data Visualization for Ohio University Alumni.

Fig. 7. Hierarchical Data Visualization for Ohio University Alumni.

TABLE II.   COMPARISON OF EXISTING MODEL OF ALUMNI DATA VISUALIZATION

Characteristic	Existing Model of Alumni Data Visualization				
	University ofColorado Boulder	*Institutes of Fine Arts (IFA), NewYork University*	*Universiti Malaysia Sarawak (UNIMAS)*	*Universiti Islam Antarabangsa Malaysia (UIAM)*	*Heritage Collegeof Osteopathic Medicine, Ohio University*
Category of data visualization	Multidimensional, Hierarchical and Geospatial data visualization	Network and Multidimensional data visualization	Multidimensional data visualization	Geospatial data visualization	Multidimensional and Hierarchicaldata visualization
Technique	Bar graph, treemap chart and Choropleth map	Network map and bar graph	Stacked bar graph	Choropleth map	Pie chart and Treemap
Strength	Search and filter function to enable user to search for specific data easily, Use of simple colors that make the dashboard look neat and not messy	Several colors are used to represent the employment categories and display in the bar graph and use of search and filter function	University used stacked bar graph to show the trend of alumni graduates based on their level of study	Used choropleth map to visualize the alumni state. Visitor can hover over the map and the number of alumni is displayed for the country chosen	The pie chart divided into four sections with different colors to enable user to see the data explicitly. The tree map chart divided into four different colors to indicate the different alumni specialization
Drawback	No use of network and temporal data visualization because no data related to time and association.	Do not use geospatial, temporal and hierarchical data visualization because the dataset involved is not related to this type of data visualization	Do not use an interactive dashboard. Thus, the visitor can only view the website for the alumni data, and they cannot interact with the data. This data visualization only uses multidimensional. Thus, the presentation of data is not completed	Do not use an interactive dashboard for their data visualization. Use geospatial data visualization to visualize alumni state, many alumni data are not shown, and the visualization looks simple	Do not use geospatial, temporal and network data visualization because the dataset involved is not related to this type of data visualization
Comparison to research topic	The use of the same type of data visualization to visualize the alumni data but with more parameters and categories	The use of the multidimensional data visualization for several data types in the alumni dataset	Alumni visualization developed in this research study can enhanced this issue by implementing the interactive dashboard for the alumni and incorporate other types of visualization to represent different types of alumni data	Inherit the geospatial data visualization from the university but including more type of data visualization so that more alumni data can be visualized to user	Include the same types of data visualization to visualize the alumni general data and alumni occupation data.

This study uses multidimensional data visualization the most because the dataset used has many parameters. This study uses the same technique to visualize alumni employment data based on their salary range. The study also uses hierarchical data visualization to show alumni job domain. The data visualization also enables the search and filtering function.

III.   METHODOLOGY

This study aims to develop an interactive dashboard with the visualization of alumni data for the alumni. It adopts the dashboard development process throughout the development phase [17]. The dashboard development process consists of three main phases, which are the conception phase, visualization phase and finalization. In this study, there are three types of alumni data that will be used to develop the dashboard for alumni visualization. The alumni data include alumni general data (gender, age range, and program name), and alumni employment data (job domain and salary range).

A. Conception Phase

There are three main activities during this phase. The first activity is to identify the primary audience for dashboard. The second activity is the main questions. The third activity is the theme.

- Identify primary audience: In this study, the primary end-user audience for the interactive dashboard is the alumni management staff of the university. The alumni of the university, parents, and public can also view the exploratory dashboard.

- Main questions: The questions focus on the purpose of the dashboard development and what the dashboard can do to answer the user's questions. Nine questions serve as the main ideas for the exploratory dashboard. The list of questions ensures that an exploratory dashboard can be developed and delivered based on these ideas. The list of questions is created based on several websites.

- Theme: this study aims to develop the exploratory dashboard, which uses the types of data visualization to answer the main questions. Alumni general data will be visualized by using hierarchical and multidimensional data visualization. Alumni employment data will be visualized using multidimensional data visualizations.

B. Visualization Phase

Three main elements need to be considered during this phase. The first element is the primary views. The second

element is the support views. The third element is the layout. During this phase, a prototype for the alumni data visualization is designed.

- Primary views: The primary views are views that visually address the main questions gathered for the specific users and align with the theme that has been selected.

- Support views: The support views are the contributory or helpful views that support, refine or add context to the primary views. For instance, the search or filtering function where the dashboard enables users to engage with the dashboard by enabling searching for alumni by state or filtering the alumni data by years of graduation or by salary range.

- Layout: It is a placement and alignment of views that focus users' attraction on the primary views and supporting views placed around them and visual indicators highlighting how the support views interact with primary views.

C. Finalization Phase

In the finalization phase, there are two main activities taking place. The first main activity is the interactive elements. The second activity is perfect and feeling. At the end of this phase, evaluation is carried out through convenience sampling to evaluate the exploratory dashboard based on certain factors.

- Interactive elements: The interactions between the primary views and the supporting views are set up in a logical, progressively detailed sequence during this activity.

- Perfect and feel: The alignments, the fine-tune color, fonts, and fonts consistency will be finalized and ensure adherence to visual standards.

IV. RESULTS AND DISCUSSION

This study developed an exploratory dashboard of alumni data visualization for Universiti Teknologi MARA. The alumni data visualization is illustrated in several diagrams of the preliminary design using Power BI.

A. Pre-Processing in Power BI

The secondary data has approximately 714 alumni from three cohorts including graduate from March 2020, November 2020, and June 2021. The cleaning process filtered private and personal information. After that, we examine the dataset to discover any issues on the data that can lead to incorrect analysis and avoid from showing the irrelevant result.

In this study, there are two major tables for the alumni dashboard visualization. These two tables consist of alumni data for cohorts 2020 and 2021. The chosen columns are year of graduation, age, gender, program name, job domain, and salary range. From the columns, multidimensional data visualization is used to visualize alumni age range, gender, program name, and salary range. Meanwhile, hierarchical data visualization is used to visualize alumni job domains. This alumni data visualization embedded filtering function by using slicers.

The data columns in the slicers are year of graduation, gender, salary range and the job domain. Before creating the exploratory dashboard, a theme for the alumni data visualization has been decided and applied to ensure that all report items or panels are consistent. In this study, the alumni exploratory dashboard uses a blue and grey colour as an overall theme for the dashboard. The exploratory dashboard has two retrospective pages. The exploratory dashboard is specific to overview alumni data and their employment details.

B. Descriptive Analysis

Fig. 8 shows the visualization of the alumni details based on the total number of alumni, the gender, the age range, the program name, and the job domain for the alumni.

The top of the dashboard displays the total number of alumni. About 500 of them are female alumni while 214 alumni are male. The data for the gender of alumni are represented using a pie chart that communicates a part-to-whole connection within the data. The age range is represented in the format of a horizontal bar graph. Alumni's ages ranged from 24 to 30 years old with 70.03% identified as female while another 29.97% identified as male alumni.

There are 10 programmes offered in this dashboard and represented using vertical bar graph. The program with highest number of alumni is Bachelor of Actuarial Science with 164 alumni and majority are female. The second highest number of alumni is Bachelor of Information Technology with 106 alumni.
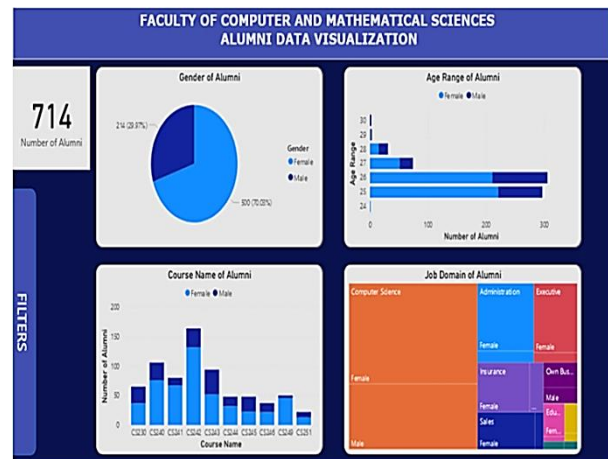

Fig. 8. The Visualization of Alumni General Data.

In terms of job domain, the data is represented in the form of a tree map chart. Most of the alumni were successfully employed in their respective field of study which is computer science with 56.3% which is equivalent to 402 alumni. Most of the alumni who are working in the computer science domain work as system analysts, programmers, and web developers. However, some of the alumni are working in other sectors that are not related to their field of study.

Fig. 9 shows the visualization of alumni salary range in six categories based on the job domain. The data are visualized through multidimensional data visualization by using horizontal bar graph. For the job domain in computer science,

most of the alumni have a salary range from RM2501 to RM3000. Majority of the alumni are working as system analysts, web developers and programmers. The job domain with the highest number of alumni is in the administration field that a salary ranging from RM1001 to RM1500. It is a challenge to the university to ensure that the graduates can be employed in the related field to their studies.
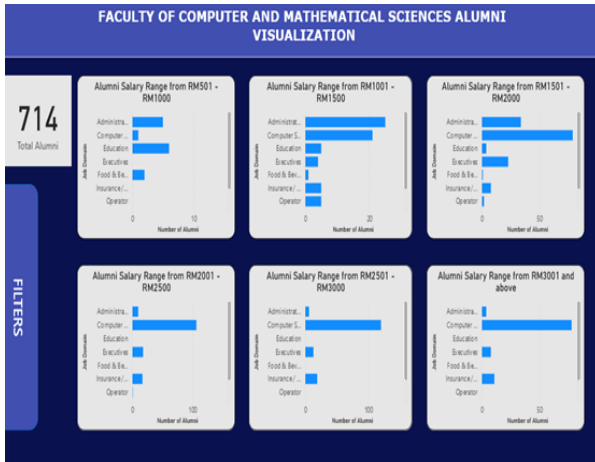

Fig. 9. The Salary Range of Alumni based on their Program.

C. Diagnostic Analysis

In this study, there are several anomalies and abnormal occurrences from the alumni data visualization. There are several alumni work in the job domain that are irrelevant to their field of study in the university. For example, aside from the computer science field, most of the alumni are working in the administration line of work as admin assistants, executive, salespeople, operator, and teachers.

Most occupations in computer science field require specific skills such as knowledge in multiple programming languages and proficiency in coding a software program. Some alumni may feel not confident to pursue their career in the computer science field. Thus, they change their interest to work in the field that they are comfortable with. The observation result is aligned with the finding from the study done by Salas-Velasco [18] on education-job mismatch in the labour market for graduates of universities.

Secondly, there is an anomaly in the alumni salary's visualization. Unfortunately, some alumni are working in computer science with a low salary of RM1500 and below. According to recruiting businesses and analysts from the article reported by Institute of Strategic and International Study (ISIS) Malaysia on their website, fresh graduates in computer science have low beginning salaries because they lack digital skills in an increasingly competitive market and an uncertain economy [19].

Some of the software businesses that hire these fresh graduates are usually start-up companies that unable to offer a high beginning salary for the fresh graduates. With the high competition for employment in gigantic computer science companies in Malaysia, some alumni have no choice but to accept the offer from the small company with the lowest salary paid.

D. Evaluation

After developing the exploratory dashboard for the alumni data visualization, an evaluation is done by conducting a convenience sampling method using survey form.

The alumni data visualization is evaluated based on the simplicity, choice of visualization, layout, filtering features, and view of the exploratory dashboard in mobile phone. Majority respondents agreed on the simplicity of exploratory dashboard. They can interpret easily. The amount of data is also sufficient as there are no data overload that led to messy representation of the alumni data visualization. Most respondents also agreed on the selection of the visualization types. However, they suggested the change of color to a brighter tone. Most of the respondents agreed and were satisfied with the arrangement of the layout for the visualization.

The respondents suggested to enlarge the font size to ease the view the information from dashboard. Most respondents agreed that the filtering function is useful as it enables them to navigate throughout the data visualization and locate the specific data and information. The filtering function encourages the interactivity between the viewer and the data visualization. The respondents can navigate the data visualization by hovering over the chart and viewing the information of that specific chart. They also can select the data by filtering data from the slicers.

Most respondents agreed that the display in mobile view is quite inconvenience and difficult to navigate compared to the desktop view. Overall, the respondents were satisfied viewing the exploratory dashboard as they enjoy the navigation from one chart to another chart to visualize the alumni data.

E. Challenges

The greatest concern in this study is the privacy issue related to alumni personal information such as home addresses, grade point, and working place. The original data set need to be pre-processed before it can be used to develop the exploratory dashboard to ensure that the private information of the alumni is eliminated from the study following the ethics of research. This can be seen as a limitation since the alumni data visualization dashboard are not able to display more variety of data visualization types such as temporal data visualization, network data visualization, and geospatial data visualization.

V. CONCLUSION

The importance of this study is to use data visualization in presenting alumni data through an exploratory dashboard and visualization techniques. The dashboard development process consists of three main phases, which are the conception phase, visualization phase and finalization. The exploratory dashboard is developed to visualize the alumni data using multidimensional and hierarchical data visualization techniques. The multidimensional data visualization includes a pie chart to visualize the gender of the alumni and a horizontal and vertical bar chart to visualize the age range, program name, and salary range of the alumni. The hierarchical data visualization includes a tree map chart to visualize the job domain of the alumni.

This alumni data visualization included a filtering function by embedding slicers in the exploratory dashboard to enable visitors to interact with the alumni data. The evaluation uses a convenience sampling method. The majority of the respondents expressed their satisfaction in evaluating the dashboard as they enjoy the fun of navigating from one chart to another chart to observe the alumni data. This dashboard can be used by the university's administrator to identify the gap between the qualification and salary range, and the relativeness of the job domain.

For future study, it is recommended to include other data fields such as state and alumni working place to have geospatial data visualization, and alumni networking data to be able to visualize network data visualization. It is recommended to have other alumni data that can support the other chart of types of data visualization such as the scatter plot, sunburst diagram, node-link diagram, and cartogram so that the alumni data visualization exploratory dashboard can be more informative and insightful.

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