IT@Singapore - A Data Visualization on the Singapore IT Industry through Covid-19 Pandemic

Muzhi Zhang

Master of Computer Science

University of San Francisco

San Francisco, California 94117-1080

Email: mzhang78@dons.usfca.edu

Abstract—This project aims to search for data that can represent how fast IT industries in Singapore grew during and after Covid-19 pandemic, and uses modern data visualization techniques to visualize these sets of data.

I. INTRODUCTION

In a news report [1], Singapore was described as a new center of economy and IT industries after a faster recovery from Covid-19 pandemic than other Asia countries. This became the motivation of this project, where data were collected and visualized to see if they can successfully prove or disprove this assumption. There were three key objectives when collecting data:

1. Find out data that show how good Singapore's Covid control was, compared with other countries.

2. Find out data that show how the labor market related to IT industries (or the overall labor market) behaves during Covid influence.

3. Find out data that show if large IT companies moved to Singapore during and after Covid-19 pandemic.

II. RELATED WORK

There were multiple papers that guided the direction of research and data searching in this project. A couple of finished visualizations found online also inspired the designing of visualization in this project.

A. Data Research

As previously mentioned, the whole project was inspired by the report on economist.com [1]. On addition to that, overall research direction was inspired by some research papers studying on other Singapore industries like Shuqiong Wu's research on AI industry [2] and Weihua Ji's research on Singapore Innovation Center program [3].

In objective 1, data source and data-handling process were all inspired from the Covid-19 section of Our World in Data website [4], where a detailed visualization about Covid-19 data in many countries was shown with helpful analyzing tools.

In objective 2, The data source and story-telling were inspired from a summary flier released by Singapore IMDA [5], which contained a research of IT industry revenue improvement from 2013 to 2018. The labor market analysis was inspired by the early study done related to the same topic: how the labor market was affected by Covid Pandemic [6].

Fig. 1. A deleted version of S pass versus work permit visualization, represented in a stacked bar chart.

B. Data Visualization Research

All visualizations in this project were built on d3v7 [7]. The selection of visualization type was guided by Fundamentals of Data Visualization [8]. Legends were created using D3 SVG Legend(V4) [9], an external d3 library. Interactive tooltips were created following the Tooltip V7 guidance from d3noob [10]. The website design and style sheet was built using a template provided from HTML5-UP [11].

III. APPROACH

A. Approach on Data Collection

In objective 1, the first approach was to collect data from each countries' official data source. However this increased the data to find and difficulty due to language issues. In the end a combined data release from Johns Hopkins University [4] was used.

In objective 2, the labor market data was collected from work permit info released by the Singaporean Ministry of Manpower [12]. GDP info was collected from The World Bank website [13]. InfoComm Industry Revenue data were collected from Singapore IMDA annual report [14].

In objective 3, the company data were manually collected by searching online for news relating to the company office opening in Singapore.
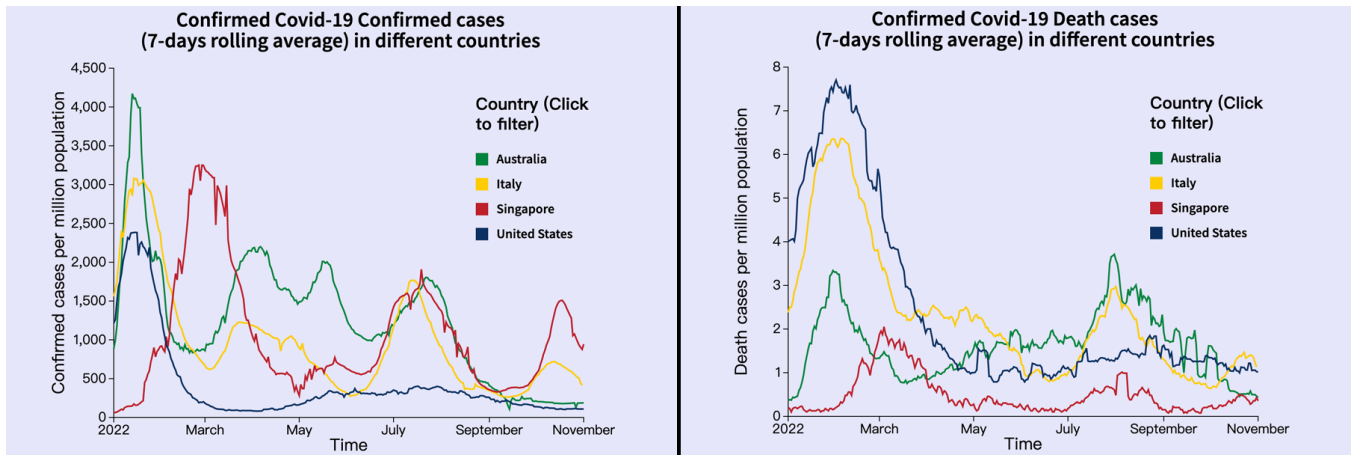
Fig. 2. The confirmed cases and death cases in Singapore, Australia, Italy and the US. Cases number are represented as per population and 7-days rolling average was used to minimize n\a data and zero data caused by different data releasing formats in each country (e.g. some countries don't release cases reported during the weekend until next business day).
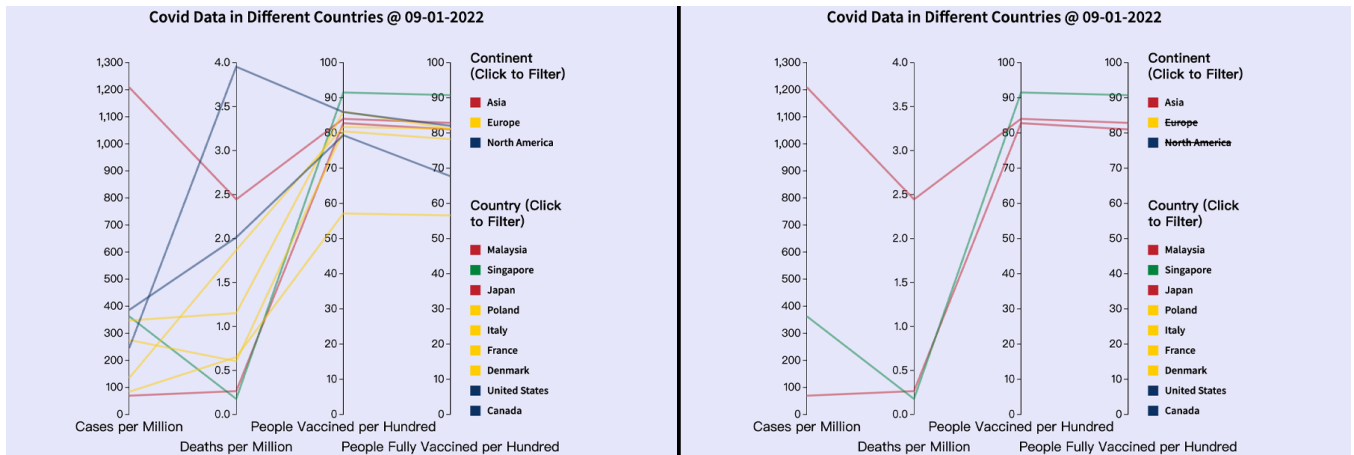

Fig. 3. The confirmed/death case per capita versus vaccination rate in multiple countries around the world. The figure on the right has non-asia countries filtered out.

B. Approach on Storytelling Implementation

To finish storytelling, three web pages were built for each objective. By clicking the navigation link at the bottom of the page, the user can travel to the next/previous page.

C. Approach on Data Visualization

In objective 1, Line charts and parallel coordinates were used to represent Covid data.

In objective 2, a line chart was used to compare GDP with IT industry revenue. A grouped bar chart was used to compare S pass and work permit issued by the Singapore government.

This part was firstly finished in grouped bar chart, as shown in Fig.1, however as mentioned in Fundamentals of Data Visualization [8], stacked bar chart can lead to misunderstanding and confusion since stacked bar chart can either represent a diagram stack on the other, or a diagram laying in front of the other, resulting on different impression.

In objective 3, a bubble chart was used to show the size, moving date and company revenue for companies moved to Singapore.

D. Approach on Interactivity Implementation

On every line chart and parallel coordinates, users can click legend to filter data, as well as using tooltip to see the current data point mouse hovers on. On the company bubble chart, users can hover on any bubble to see company info and news that referenced the move of the company.

IV. RESULTS

A. Covid-19 outcome

As shown in Fig.2, the death number and case number (calculated using 7-days rolling average) was visualized in two line charts. By comparing covid case number and death number, the visualization showed that Singapore has relatively low death cases per population, even when confirmed cases per population is high. This means that health care, vaccination

and treatment in Singapore did a very good job on controlling Covid cases becoming serious or causing death.

As shown in Fig.3, the case number and vaccination rate were visualized in a parallel coordinate. By comparing data from Singapore and other countries, the visualization shows that Singapore has a higher recovery rate and vaccination rate than not only other Asia countries, but also most of the other countries listed here. This showed that Singapore indeed had a better outcome dealing with Covid-19 Pandemic.
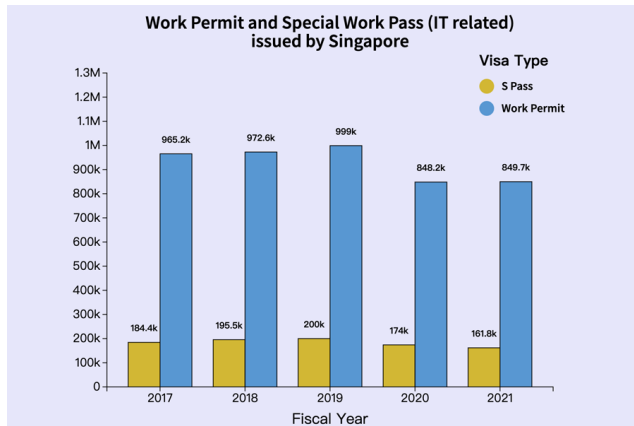
B. IT industry growth

Fig. 4. The Work Permits given by the Singapore government versus the number of S passes. S passes are for mid (or above) level skilled workers and are more related to the IT industry compared with work permits.

As shown in Fig.4, the number of 2 different labor markets were compared in a grouped bar chart. It was shown that S passes didn't decrease as dramatically as work permits during the Covid-19 pandemic, which means that high-tech related jobs didn't drop through the pandemic, but didn't increase as well, which is against the idea that Singapore was becoming the new center of IT industry in Asia (which means a huge transfer on labor market).
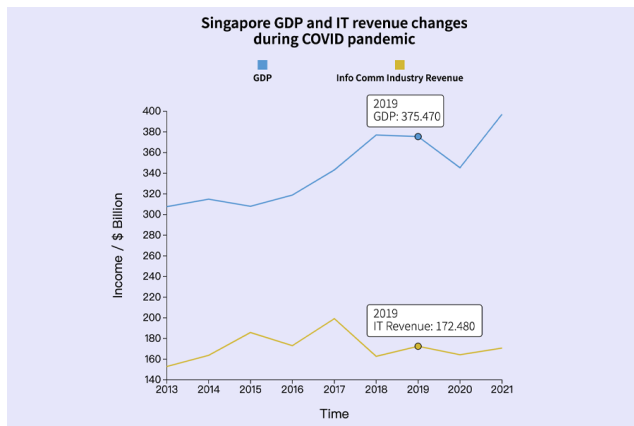

Fig. 5. The GDP growth in Singapore versus the InfoComm Industry Revenue.

As shown in Fig.5, the GDP growth in Singapore was compared with InfoComm Industry revenue in a line chart.

From the visualization, the infoComm Industry had a drop in revenue at the beginning of Covid-19 Pandemic and haven't been able to recover from it even when GDP showed a clear rebound.
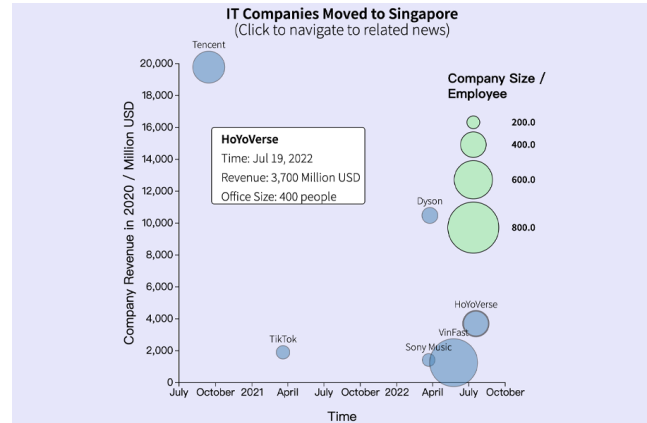
C. Companies

Fig. 6. The data of IT companies moved to Singapore through Covid Pandemic period. X axis shows the date of office moving, Y axis shows the company global revenue, bubble size shows the Singapore office size by Employee count.

As shown in Fig.6, some companies that moved to Singapore through Covid Pandemic period were gathered and their data was compared in a bubble chart. It can be analyzed from the chart that even though some big companies (Tencent, Dyson) moved to Singapore, the office size is not significantly larger than other smaller companies. This indicates that those offices act more like overseas offices instead of main offices.

V. SUMMARY

These three objectives showed that, although Singapore handled Covid Pandemic significantly better than other countries, the IT industry didn't receive a huge increase due to it. And not too many large IT companies moved their main office to Singapore. Since the visualizations on objective 2 and 3 support each other very well, they can be regarded as convincing evidence. Therefore, the assumption that Singapore has become the new IT center in Asia can be successfully disproved. The project is considered as successful.

VI. DISCUSSION

Overall, the bubble chart was the most promising approach of the project, since it allows users to compare company data in three dimensions. It was also directly related to the IT industry, which is not like the labor market approach, which might not have had enough relationship with the IT industry. After all, there were many industries other than the IT industry that required the Singapore government to give S pass. A better way to start a project would be to start from more research papers provided by Singaporean sources, which could lead to data that relate more closely to the Singapore IT industry labor market. The overall project provided a huge improvement on

the author's experience on data gathering and visualization designing.

VII. FUTURE WORK

If there were more time for research, a survey sent to actual Singaporeans would be very helpful to further enhance the evidence of labor market change. More company info would make objective 3 more convincing so that is a point for improvement, too.

REFERENCES

[1] The Economist, "The battle between asia's financial centres is heating up," Jun 2022. [Online]. Available: https://www.economist.com/finance-and-economics/2022/06/29/the-battle-between-asias-financial-centres-is-heating-up

[2] S. Wu and X. Zhao, "Study on the scientific and technological talents in key small countries based on the background of international competition——taking the field of artificial intelligence in singapore as an example," *Technology Intelligence Engineering*, vol. 7, no. 1, 2021.

[3] W. Ji and N. Su, "Features and insights of building a science and technology innovation center in singapore," *Global City Studies*, vol. 2, 2020.

[4] E. Mathieu, H. Ritchie, L. Rodés-Guirao, C. Appel, C. Giattino, J. Hasell, B. Macdonald, S. Dattani, D. Beltekian, E. Ortiz-Ospina, and et al., "Coronavirus pandemic (covid-19)," Mar 2020. [Online]. Available: https://ourworldindata.org/coronavirus

[5] Singapore Infocomm Media Development Authority, "Annual survey on infocomm industry 2019," 2019. [Online]. Available: https://www.imda.gov.sg/-/media/Imda/Files/Infocomm-Media-Landscape/Research-and-Statistics/Survey-Report/II2019_Infographics.pdf

[6] S. Kim, K. Koh, and X. Zhang, "Short-term impact of covid-19 on consumption and labor market outcomes: Evidence from singapore," *SSRN Electronic Journal*, 2020.

[7] M. Bostock, "Data-driven documents(d3), version 7.7.0," Dec 2022. [Online]. Available: https://d3js.org/

[8] C. Wilke, *Fundamentals of Data Visualization: A Primer on making informative and compelling figures*. O'Reilly Media, 2019.

[9] S. Lu, "D3 svg legend (v4)," 2018. [Online]. Available: https://d3-legend.susielu.com/

[10] d3noob, "Favorite tooltip (simple version) v7," Jul 2021. [Online]. Available: https://bl.ocks.org/mbostock/02d893e3486c70c4475f

[11] ajlkn, "Html5 up." [Online]. Available: https://html5up.net/

[12] Ministry of Manpower Singapore, "Foreign workforce numbers," 2022. [Online]. Available: https://www.mom.gov.sg/documents-and-publications/foreign-workforce-numbers

[13] Worldbank, "Gdp - singapore," 2021. [Online]. Available: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=SG

[14] Singapore Infocomm Media Development Authority, "Annual reports," 2022. [Online]. Available: https://www.imda.gov.sg/About-IMDA/corporate-publications/annual-reports