Visualizing Indonesia Trade Industry

Christine, Fresi, and Tommy Johnson

Abstract — International trade is one of the major industry contributing to Indonesia robust economic growth and development. However, amidst the ongoing United States and China trade war as well as the stagnation of the global economic growth, Indonesia experienced a trade deficit. Tracking the exports and imports related data is especially valuable to policymakers as to whether to intervene through new policy implementing or to analyse the effectiveness of the measures. Therefore, an in-depth analysis platform is strongly needed yet currently Kementerian Perdagangan Republik Indonesia only displayed the trade data in a table form. This research paper aims to analyse the available data, pinpoint trade patterns and derive insights for areas that needed more attention and eventually produce appropriate measures to counter the challenges. The visualization tools – time-series diagram, treemap, and chord are developed to aid users in analysis and decision-making.

Index Terms — Indonesia, Exports, Imports, Trade Balance, Surplus, Deficit, Economy, Trade Flow.

1 Introduction

Indonesia is the largest economy in Southeast Asia, with the key exports, include coal briquettes, palm oil, petroleum gas, rubber and crude petroleum. As such, it is not surprising that Indonesia is the 25th largest exporting countries in the world with an export value of US$188 billion in 2017. In the same year, Indonesia imported US$153 billion, making it the 29th largest importer in the world. As a result, Indonesia enjoyed a positive trade balance of US$35.1 billion [1]. Despite the positive trade balance, the exporting sector has been declining for the last five years at an annualized rate of -2.4 per cent, from US$212 billion in 2012 to US$188 billion in 2017. The importing sector has also been declining for the last five year at an annualized rate of -3.9 per cent, from US$186 billion in 2012 to US$153 billion in 2017 [1].

By the end of 2018, Indonesia had a trade deficit of US$8.57 billion as exports remained slow yet imports surged due to a recovering domestic economy [2]. Indonesia major trading partners such as China, the United States, and Japan were experiencing economic stagnation, urging Indonesia to find the new exporting destinations for its products [2]. In the first half of 2019, the import of raw and auxiliary materials fell by 7.7 per cent, reflecting the possibility of a slower production within the country and lesser investments to stimulate economic growth [3]. As such, a better understanding of Indonesian trading data in the form of exports and imports patterns over the years, trading partners patterns, and top commodities patterns is strongly needed.

Currently, Kementerian Perdagangan Republik Indonesia - Kemendag (Ministry of Trade of Republic Indonesia) provides exports and imports data breakdown by trading partners, commodities, and province in a table form report per annum. However, the utilization of such data is limited to basic descriptive information. To generate insights and spot a trend in Indonesia trade, a visualization dashboard is needed. Therefore, we present Cakrawala - a dynamic visualization platform specially designed for users to understand Indonesia trade industry in a deeper context.

Consisting of 8 main sections, this research paper reports on our research and development efforts from brainstorming, designing, and implementing the comprehensive and interactive dashboard application that helps in visualizing the exports and imports patterns and its impact on Indonesia trade balance. Section 1 and 2 provide an introduction, motivation and objectives that we wish to address in this project. This is followed by the research on the related works of Indonesia trade visualization and our visualization approach in section 3 and 4 respectively. Section 5 detailed the visualization walkthrough approach of all dashboards and their functions. Section 6 highlights the findings we acquire from the visualization while section 7 discusses the limitation to the application. Last, in section 8, we conclude our project and talks about our learning points.

2 Motivation and Objectives

Our research and development efforts were motivated by a lack of web-based visualization provided to visualize the exports and imports related data in Indonesia. It aims to provide Kemendag and other users with an analytical tool for visualizing the patterns of Indonesia trading industry. Specifically, it seeks to support the following analysis requirements:

1. Identify the top trading partners of Indonesia across the years and gain insights into the potential markets that Indonesia could explore to improve the trade industry.
2. Identify the demand of commodities products within Indonesia and other exporting partners. Analyse and gain insights into customer preference over the years.
3. Gain overall insights into Indonesia economic performances based on the trade balance patterns.

3 Related Works

Besides presenting the exports and imports data in the table form, Kemendag and Kementerian Perindustrian Republik Indonesia – Kemenperin (Ministry of Industry of Republic Indonesia) provide infographics for certain exports and imports topic. However, these existing infographics have their own shortcomings as it is static and do not allow users to filter data according to their needs. Furthermore, these infographics present fragmented information about Indonesia trade which is not helpful in generating insights.

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[1] https://oec.world/en/profile/country/idn/

[2] https://uk.reuters.com/article/uk-indonesia-economy-trade/indonesia-posts-record-trade-gap-in-2018-december-exports-sink-idUKKCN1P90AZ

[3] https://www.thejakartapost.com/news/2019/07/16/data-points-to-slowdown-in-indonesian-economy-amid-ongoing-trade-war.html

Referring to Figure 1 from Kemenperin, we can pinpoint the Non-Oil and Gas sector made up of 90.93 percent of total Indonesia exports. The next pie chart shaded in red highlights the contribution of Manufacturing sub-sector (83.57 percent) to the total exports of Non-Oil and Gas while the blue shaded pie chart shows Manufacturing sub-sector contributed to 75.99 percent of total Indonesia exports.

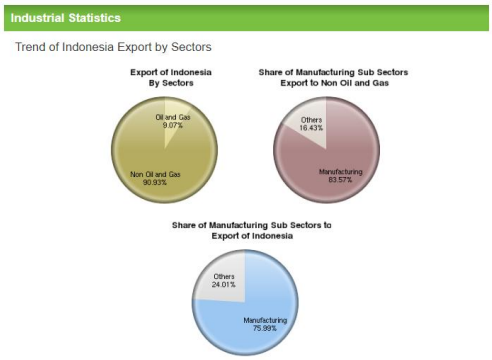


Fig. 1. Growth of Indonesia Exports by Sector

However, the pie charts lack the "time" element as we do not know which year the data refers to. Further, we do not get the information on what kind of products fall under Oil and Gas and Non-Oil and Gas, and hence the information we gathered is very fragmented. In summary, it is also difficult to comprehend and draw relations from these pie charts even though they are related. A bar or line chart should be used to display the trend of exports per sector over the years. Additionally, inserting information about what products fall under Oil and Gas or Non-Oil and Gas will be useful for users. Also, adding filters or tooltip containing the real value of exports (in US$ format) per sector will be more valuable.

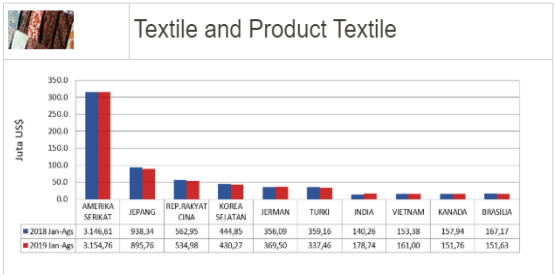


Fig. 2. Export Destination Country for 10 Main Commodities

Looking at Figure 2 from Kemendag, we can identify the export destination countries for 10 main commodities. However, the charts merely display the data for the period of January – August 2018 and January - August 2019; the insights given is insufficient when we intend to see the trends of top commodities for exports and imports. Moreover, other commodities products are omitted. One way to overcome such limitations is to make it dynamic by providing filters for year and type of commodities. Through the filters, users can analyze the chosen commodities within the chosen year and spot a change in demand by customers.

We also looked on Singapore trade visualization provided by Singstat to broaden our research beyond just Indonesia. As seen in Figure 3 below, the horizontal bar chart has a modern look and feel. It also displays the value of export and import per country.

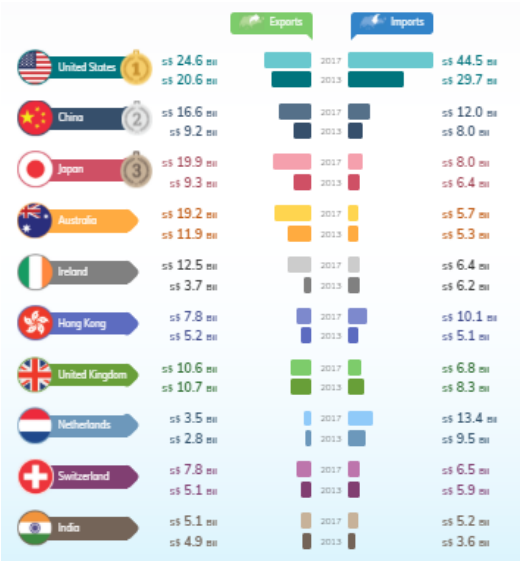


Fig. 3. Top 10 Exports and Imports Trading Partners

It would be better if the data is displayed interactively by providing the input slider such that users can adjust the time frame. Furthermore, a dropdown filter to select the top K trading partners would be more useful instead of omitting all the other trading partners.

In summary, our group had gained a deeper understanding of the current visualization's measures. We had brainstormed and design our application to be more dynamic and interactive with the help of filter and tooltip.

4 Visualization Approach

The team collected all the required data from Badan Pusat Statistic – BPS (Statistics Indonesia) and Kemendag based on its relevance to our main objectives, motivations, and brainstorming designs. There are 3 main steps taken to develop the visualizations: (1) Exploratory Data Analysis (EDA), (2) brainstorming and dashboards planning, and (3) data cleaning, pre-processing and visualization implementation.

4.1 Exploratory Data Analysis (EDA)

There are 85 datasets published by BPS which are related to Indonesia trading[4]. First, we categorized each data into 2 big groups of Exports and Imports. Through EDA performed in Microsoft Excel, we learnt the Indonesia exports are classified into Oil and Gas and Non-Oil and Gas, where the latter is further broken down by Agricultural, Industry, Mining, and Others. On the other hand, imports in Indonesia are grouped by Consumption Goods, Raw Material Support, and Capital Goods.

Next, our team began exploring the major exports and imports commodities to Indonesia and we learnt the top exporting commodities are garments, iron steel, and electrical equipment while the top importing commodities are petroleum, industrial machine and telecommunication equipment. Additionally, we explored the top trading partners of Indonesia based on the value of exports and imports by countries and province. We are able to spot China, Japan, Singapore, and the United States as Indonesia' top trading partners.

[4] https://www.bps.go.id/subject/8/ekspor-impor.html#subjekViewTab3

We also explored top export and import commodities of Indonesia. All these explorations are done in Tableau.

4.2 Brainstorming and Design Consideration

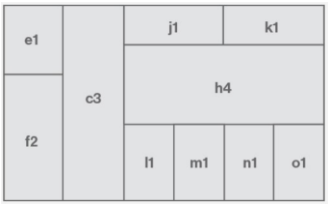
After EDA, the team researched on various visualization ideas and r packages that we could use to produce the graphs. Our team discussed on each graph's suitability and make sure each graph that we chose are the best representation in term of clarity and aesthetic. We matched each dataset to the graphs to ensure data is accurately presented. Furthermore, we also planned on interactivity available for the graphs. We used whiteboarding to group each graph under the correct dashboard.

To show trading patterns and proportions of commodities goods per year, our team utilized these following graphs:

4.2.1 Line and Bar Diagram

Even though it is simple, bar graph is useful in showing the relationship between different data series that are independent of each other while line graph highlights the trends over a period. As most of our data are broken down by years, line and bar diagrams are suitable to display the change of exports and imports over time.

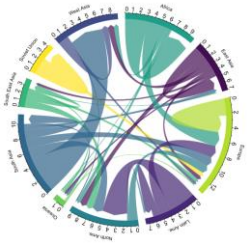
4.2.2 Treemap Diagram



A treemap diagram enables our group to display the hierarchical data that uses nested rectangles. Each rectangle has different area based on the proportion of the value out of the total amount. As one of our objectives is to identify the demand of commodities products in and out of Indonesia, treemap is the suitable graph we could utilize.

4.2.3 Chord Diagram

The chord diagram is used to visualize the weighted relationship of trade volume between Indonesia and its trading partners. Each country is represented by a fragment on the circle's outer part while the arcs connect the data points.



4.3 Data Cleaning, Data Pre-processing, and Implementation

In order to fit the data into the desired graph, we used Microsoft Excel to remove the redundant information in the graph such as the title, additional information, the total of the export or import value. Next, we used tidyr and dplyr to filter, subset, mutate, aggregate the data as needed by the specific graph before plotting the graph using plotly.

After each dashboard implementation, our group will look into additional improvements by adding informative tooltip and adding filters whenever necessary. We believe filtering function enables users to focus on the selected information instead of looking through a large set of data. Eventually, our group aims to facilitate the information gathering and insights generation that aid in decision-making.

5 Data Visualization Walkthrough

There are 6 main dashboards available in our application, which are:

5.1 Home

The homepage is designed to give the overall overview of Indonesia exports and imports trends as well as the trade balance over the years.

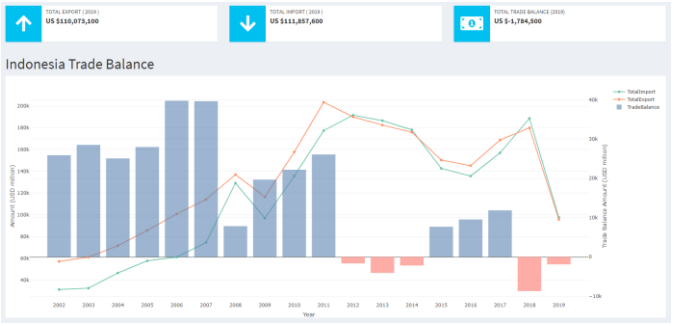


Fig. 4. Indonesia Trade Balance Trend

The line graph in Figure 4 is useful in showing the change of export and import value over the years while the bar graph displays the trade balance values. When the users hover over the graph, the total value of exports, imports, and trade balance will be highlighted by the tooltip.

Fig. 5. Magic Quadrant of Indonesia Trading Partners

Next, we classified the trading partners of Indonesia under the 4 quadrants; from top left is (1) low exports and high imports, (2) top partners, (3) untapped market, and (4) high exports and low imports.

5.2 Import and Export

We further broke down the trade visualization into Import dashboard and export dashboard. Each dashboard consists of 6 sub-pages of:

5.2.1 Product Category

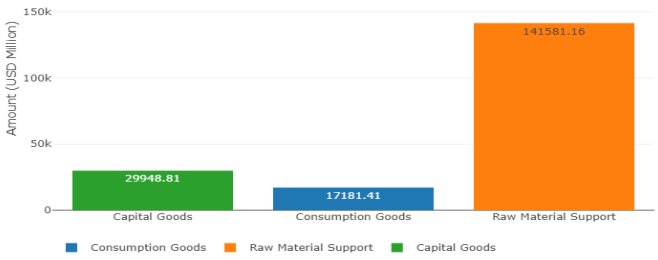


Fig. 6. Import Product by Category

Figure 6 grouped the import of Indonesia into 3 big categories, (1) Capital Goods, (2) Consumption Goods, and (3) Raw Material Support. We can see raw material support has the highest proportion of goods being imported into Indonesia.

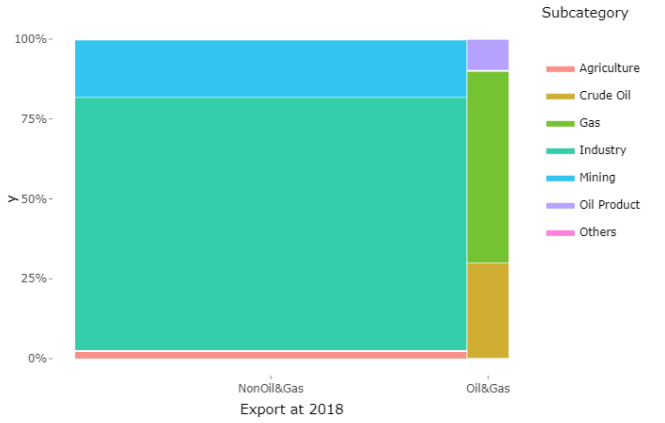


Fig. 7. Export Product by Category

Figure 7 categorized the exported goods into Non-Oil & Gas (made up of agriculture, industry, and mining) and Oil & Gas (made up of oil product, gas, and crude oil). Through 'Year' filter, users can see the change in each sub-category proportion of import or export.

5.2.2 Top Importer / Top Exporter

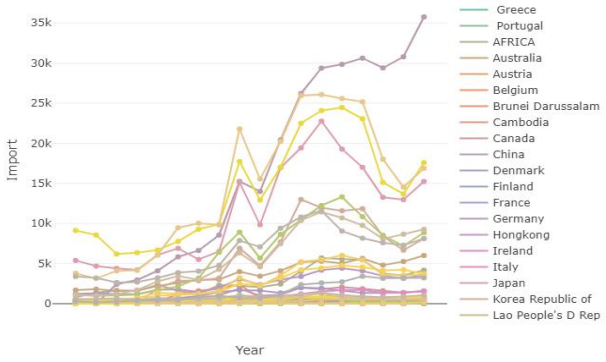


Fig. 8. Top Importer of Indonesia

Figure 8 ranked the import partners of Indonesia in ascending order. Users can select how many countries they would like to see in the drop-down filter. The graph enables users to view the top trading import partners of Indonesia and compare the import performance on yearly basis. Similar function is available for Top Exporter.

5.2.3 Location of Importers / Location of Exporter

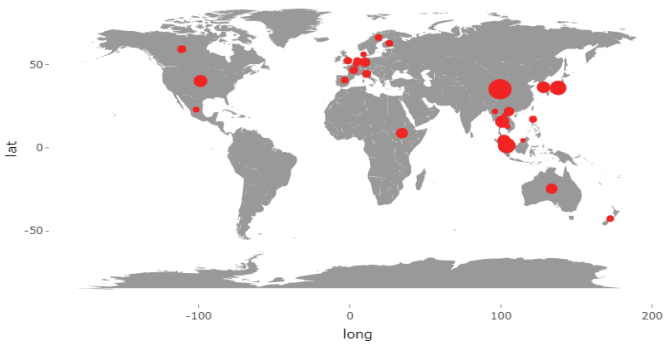


Fig. 9. Location of Import Partners of Indonesia

The map in Figure 9 displayed the location of Indonesia's import trading partners across the world. The size of the circle represents the value of imported good in term of US$. Users can select the specific year available in the filter function.

5.2.4 Product Sub-category

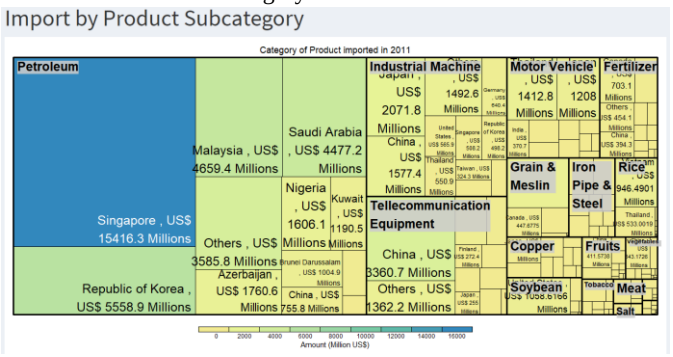


Fig. 10. Import by Product Sub-category

The treemap in Figure 10 showed the proportion of imported products into Indonesia on a yearly basis. The area of the rectangle represents the amount of imported goods while the colour highlights the countries by imported amount. Users can identify the major imported or exported goods classified by trading partners.

5.2.5 Trend of Sub-category

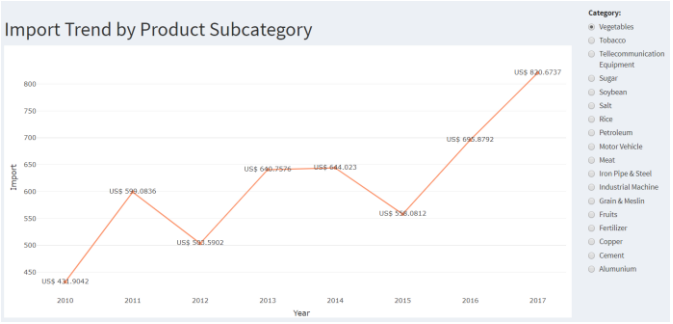


Fig. 11. Import Trend by Product Sub-category

Figure 11 illustrated the change of imported goods by product sub-category over the years. Users can select the category of product and monitor the trend for further analysis.

5.2.6 Importers by Sub-category

Fig. 12. Map of Indonesia Importers by Sub-category

The map in Figure 12 displayed the location of the trading partners based on the year input and the product sub-category input selected by the users.

5.3 Trend of Trade

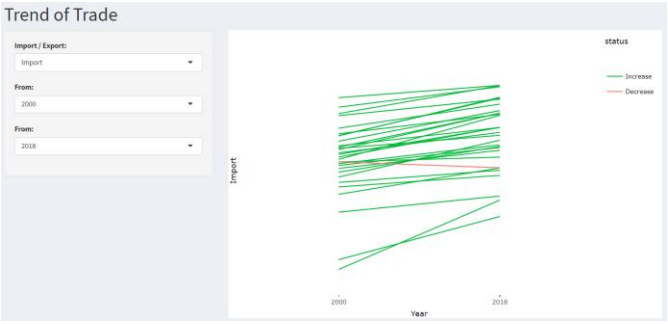


Fig. 13. Trading Trend of Indonesia

The slope graph in Figure 13 illustrated the change of imported or exported value based on users' input on time frame. The green line represents the increase while the red line represents the decrease in the value of exports or imports. Overall, users could spot the country/ies with a decreasing value of exports or imports.

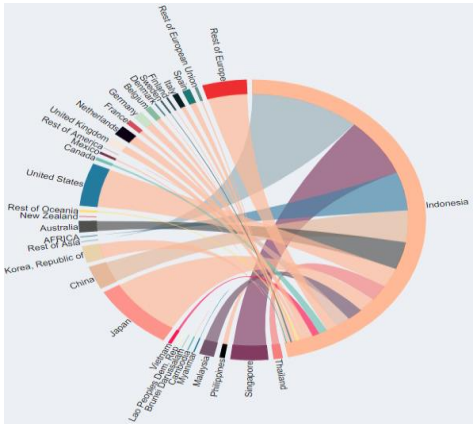


Fig. 14. Trading Trend of Indonesia

Figure 14 demonstrated the relationship of Indonesia with its trading partners. A filter to select the year is available for the users. When hovering over the arc, the 2 ways relationship is displayed in the value form.

5.4 Ports of Indonesia

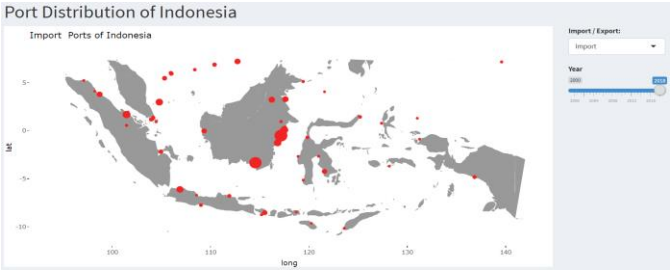


Fig. 15. Trading Trend of Indonesia

Figure 15 showed the location of ports across Indonesia. The circle size represents the value of export or import. Users can select the year they would like to investigate. Through this map, users could plan for better trading flows across Indonesia.

6 Key Findings and Observations

There are several key findings and observations obtained through this visualization. They are:

6.1 Objective 1: To identify trading partners and gain insight on the new market

Fig. 16. Top Partners and Untapped Market Quadrant in 2002

Singapore, China, Australia, Malaysia, United States, and Japan were identified as Indonesia top trading partners in 2002 whereas Germany, United Kingdom, Philippines and etc were classified under the untapped market for Indonesia.

Fig. 17. Top Partners and Untapped Market Quadrant in 2018

In 2018, we see Germany, United Kingdom and Philippines had shifted to become Indonesia top trading partners.

Using the magic quadrant diagram, users can monitor the trading relationship of a country in relation to Indonesia, accompanied by external factor such as trade war, or import bans. In-depth researches could be performed to strategize on the future trading plans with the top trading partners as most of these countries' economy are stagnating, e.g. China, and United States. To identify the new potential market, Indonesia should focus on the countries categorized under the untapped market quadrant.

6.2 Objective 2: Identify the demands of commodities and gain insights on customers' preferences

It is important for Indonesia to understand the demand and supply of products of its own citizen and its trading partners.

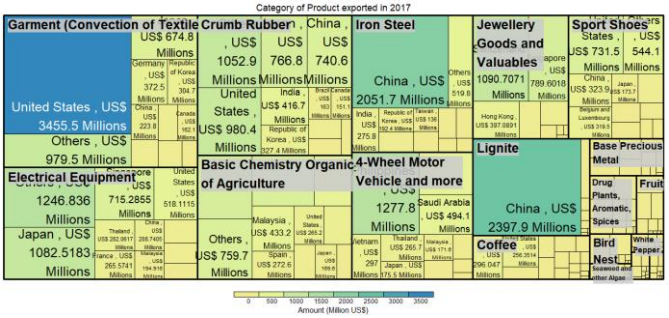


Fig. 18. Export by Product Category in 2017

Yearly, the top export commodities of Indonesia were garment, electrical equipment, and crumb rubber. The government should focus on maintaining the production of these commodities while at the same time look for opportunities to export more of the smaller scale commodities such as coffee and bird nest.

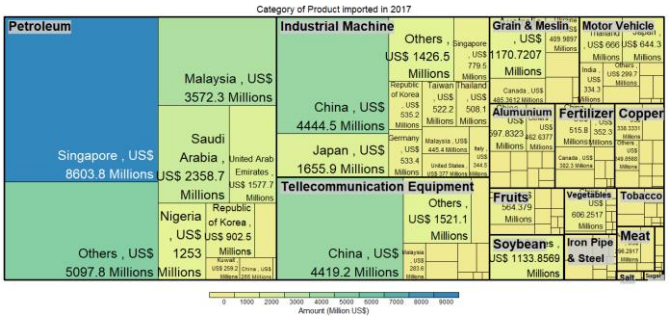


Fig. 19. Import by Product Category in 2017

For import commodities, petroleum is the major imported commodity in 2017, followed by industrial machine and telecommunication equipment.

It is important to identify whether the import products are used for consumption or used for other goods production. By knowing the proportion of exported and imported goods, Indonesia could better plan its production volume or take measures to produce the products locally instead of importing them especially now Indonesia imported more than it exported.

6.3 Measure economic performance of Indonesia based on its trade balance

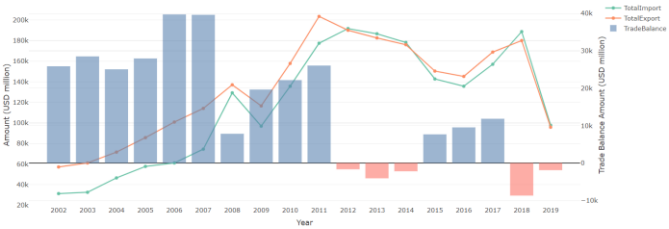


Fig. 20. Trade Balance Patterns

Based on Figure 20, Indonesia had a trade deficit in 2012 – 2014 which signal the low production. Although, Indonesia managed to record a trade surplus from 2015 - 2017, the value of exports and imports in those years were dropping. Further, we can see a sharp decrease in exports and imports amount as of August 2019, which could reflect a slower production that might lead to less investment and therefore signal a slowdown in exports.

7 Limitations

The trading data used in visualizing our graphs are only a one-to-many relationship between Indonesia and its trading partners. Hence, users could not analyses the many-to-many relationship in our application. Further, our data do not consist of exports and imports of service. Last, the 2019 trading data only includes month of January to August which may reduce the accuracy of the trade balance pattern.

8 Conclusion

Overall, our team find it is challenging to analyze and visualize the trade industry of Indonesia. A deep research and efforts are needed to understand the classification of imports and exports as well as comprehending what does the trade figure means to Indonesia economy. However, throughout the process of design and development, our team learnt many valuable lessons. From technical aspect, we were exposed to multiple R packages such as dplyr, tidyverse, ggplot, treemap, mapdata, and chordiag. Out team realized how important is data cleaning and data pre-processing as it made up of 70 percent of our code. From our trading topic, we had the chance to know more about Indonesia trade situation and its economic performance.

We believe our current application can be further improved in term of user interface and aesthetic. For future research, our team could explore the following areas, such as:

- Include the exports and imports of service to create a more comprehensive trade visualization application.
- Make the application to be dynamic to visualize data in real-time.
- Include the predictive model of exports and imports performance.

Acknowledgments

We would like to thank Professor Kam Tin Seong for his guidance during classes and consultation sessions. His valuable inputs had helped us to implement changes that improved our visualization and make sure we were on the right track.

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