GPExploreR: Singapore Government Procurement Analysis

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Introduction

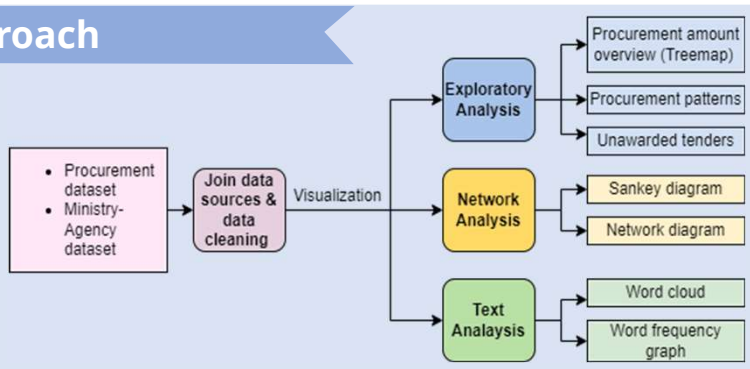
Singapore public sector procurement is mainly done via GeBIZ, an e-procurement portal where public agencies publish invitations for quotations and tenders. Currently GeBiz has two separate procurement analytics tools, namely GeBIZ InSIGHT and GeBIZ Management Console (GMC). GeBiz InSIGHT aims at allowing procurement officers to gain insights into the potential procurement opportunities. GeBIZ Management Console (GMC) aims at providing decision makers with visibility of public procurement. Although these tools allow insight gathering for decision making, they are aimed at public sector level. An improvement on this would be making it transparent to the suppliers as well, enabling them to gain insights on potential market opportunities. A single platform consisting of analytics targeted at both supplier and public agencies would also improve the procurement efficiencies.

Motivation

For public sector procurement, there is a need to identify areas where there is possible over-reliance on a particular supplier. Such over-reliance could point to risks or possible irregularities that would need to be investigated.

Identifying common procurement needs of various public agencies could also reveal areas for synergy. For example, for goods and services that are required by most agencies, the public sector could call a whole-of-government (WOG) bulk tender, leverage on economies of scale, and thereby procure goods and services at more favourable rates.

Approach

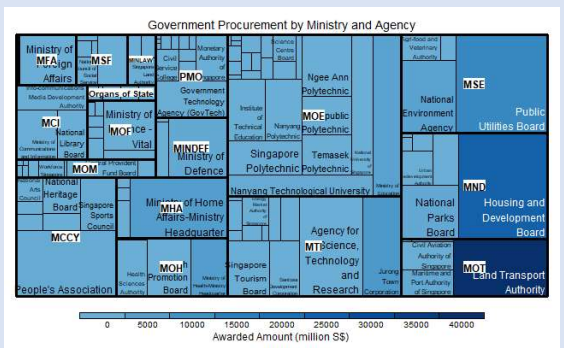


The application aims to provide an interactive user-interface by the following analyses:

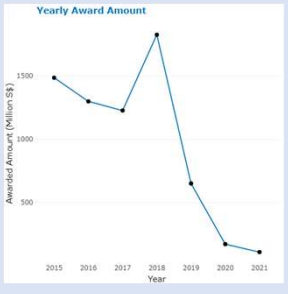
1. Conduct exploratory data analysis to gain overall understanding of the procurement pattern of both awarded and unawarded tenders at ministry or agency levels
2. Network analysis
    1. Network diagram to identify the key interactions between public agencies and suppliers
    2. Sankey diagram to identify key suppliers that are heavily relied on by the public sector
3. Text mining through word cloud and frequency analysis to identify the common nature of procurement of each public agency. Topic modelling was also used to study the salient terms and identify project types from tender description.

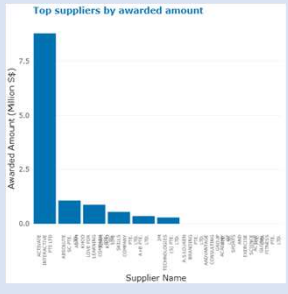
Results & Insights

Exploratory Data Analysis



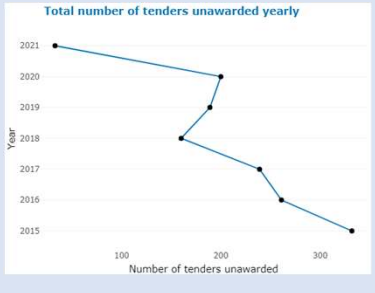
Treemap is a useful way to visualize hierarchical data in a nested way. Different representations can be made from treemap with size of tiles showing the number of procurement orders and color of tiles showing the procurement amount. It provides a useful visualization to identify the key spenders in each hierarchy. From the treemap of government procurement by ministry and agency, the top ministries with highest number of procurement orders are Ministry of Education, Ministry of Trade and Industry, Ministry of Sustainability and the Environment, Ministry of National Development, Ministry of Transport. Among the agencies, Public Utilities Board, Housing and Development Board and Land Transport Authority have the highest procurement expenditure during 2015-2021.

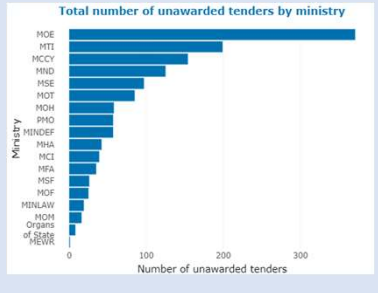




Procurement pattern of Ministry of Health

By deep diving into Ministry of Health, before and after covid-19 pandemic procurement shows interesting patterns. Before the pandemic, the overall procurement amount was above S$1000 million, with a hike in 2018. This is probably due to the Healthcare 2020 master plan which was announced in 2012. Hence, more hospitals and healthcare facilities had to be contracted. However, during the pandemic, the procurement amount decreased drastically from 2019 to 2021, and MOH is one of the ministries with lower procurement expenditure as seen from the treemap. Covid-19 pandemic should be resulting in a upward trend in procurement amount by MOH but actually it decreases. Moreover, from the top suppliers by awarded amount, Active Interactive Pte.Ltd occupies a large portion of the contracts by MOH, which monopolize the market.





In terms of unawarded tenders, Ministry of Education has the highest number of tenders unawarded which is close to 400. This implies that more resources are needed for education related contracts despite MOE's procurement expenditure being one of the top among all the agencies. On the other hand, the total number of tenders unawarded has dropped drastically over the years, especially during 2020 to 2021.

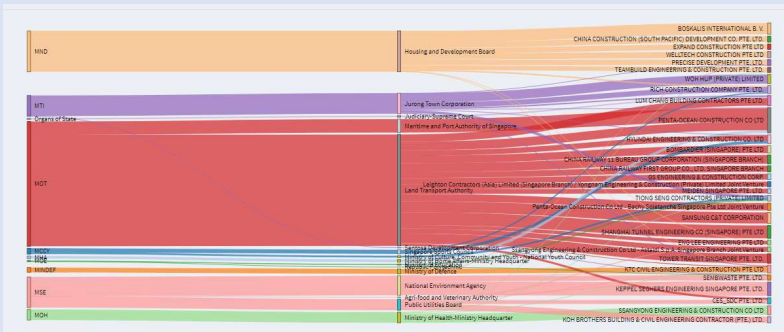
Results & Insights

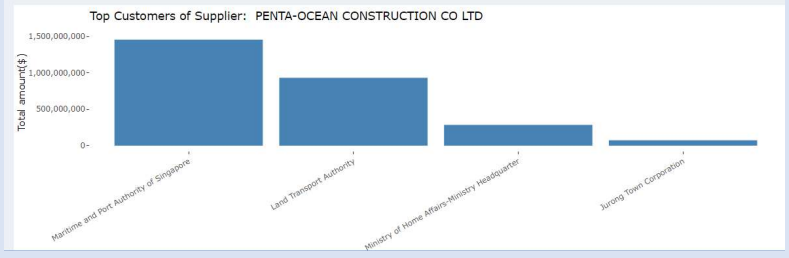
Network Analysis

Sankey Diagram

Using the Sankey Diagram, users can identify top suppliers that are common among across the public sector or within a ministry. Users would be also able to view the top suppliers of a selected supplier from the Sankey Diagram.

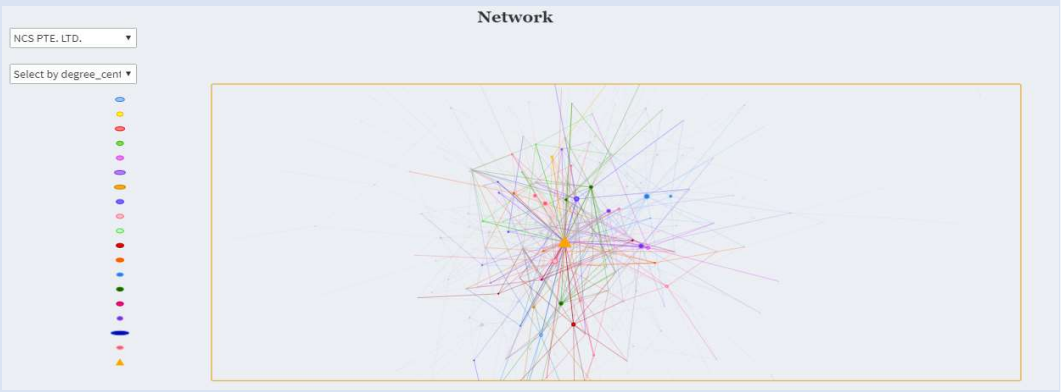
From the Sankey Diagram for the entire public sector from 2018 to 2021, the Ministry of Transport (MOT) procured the most from the top suppliers. This is followed by the Ministry of National Development (MND) and Ministry of Sustainability and the Environment (MSE). The top supplier, Penta-Ocean Construction Co Ltd's 2 biggest customers MPA and LTA are under MOT.





Network Diagram

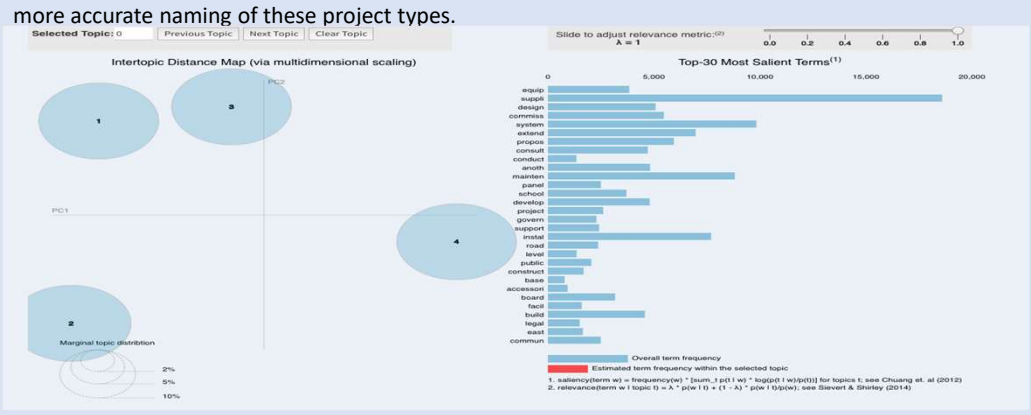
The Network Diagram would show the linkages among the suppliers and agencies. Node sizes reflect the degree while edge thickness reflect the awarded amount between the supplier and agency. The supplier with the largest node size is NCS Pte Ltd, indicating that while NCS does not show up as a top supplier in the Sankey Diagram, it has numerous dealings of smaller value with many different agencies.



Text Analysis

LDAvis

By treating each tender project record as a document, the team can cluster tender projects together based on a set of relevant salient terms used across these records. Four main topics are found across these set of records, namely: Installation and Manpower , Planning and Management, Construction and System and Public Facilities. The names of these topics were largely helped by LDAvis, a visualization built to allow users to view topic word clusters and word frequency of salient keywords. LDAvis when provided on the dashboard, will provide for additional transparency as to how these project types were formed. Naming categories are subjective and such a visualization provided for its users will allow for feedback for more accurate naming of these project types.



Word Cloud and Tree Map

As seen below, the word Cloud aids in highlighting keywords based on frequency. The word cloud would thus serve to highlight prominent types of projects based for specific topics, agency or supplier. Given time-period filter, we can further analyze word cloud by time periods.

For example, users can analyze the build and construction authority tender projects before and after covid-19 pandemic (seen word cloud below). Before the pandemic, the authority was concerned with going "green" and "Build tech Asia events". However, after the pandemic, notice a shift in the frequency distribution of words to include more words at the same minimum terms shown. After the pandemic, the authority was concerned with "material" notability "sand" this is consistent with the fact that there was a sand shortage during the pandemic; more jobs were tendered to suppliers with such materials. The complimentary tree map would provide additional insights as to who tendered for this agency before and values in terms of award amount (portion of tree map). This will allow the users to know the variety of suppliers engaged, who the agency has worked with and who are the high tender amount suppliers.

1 Year Before Pandemic

1 Year After Pandemic

Complimentary Tree Map

Future Work

- Based on the topic modeling results, suppliers could be clustered based on the nature of services provided by each supplier. Network analysis could then be used to visualize the different supplier clusters and the relationship of supplier clusters with agencies. This would facilitate identifying the nature of services procured by each agency and ministry.
- More information about the suppliers could value add to the analysis to understand if a supplier is the monopoly in the market, its competitiveness and overall financial health.