GeVIZ: Who Supplies the Needs of Singapore? Introducing A Way to Streamline Operations and Improve Efficiencies

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Abstract— Launched in 2000, the Government Electronic Business (GeBIZ) Portal is an integrated portal for use by all Singapore government agencies to conduct business electronically with their suppliers. There are more than S\$10 billion worth of business opportunities published annually to 30,000 suppliers registered with GeBIZ. Over the years, GeBIZ has accumulated a knowledge base of procurement data and massive amounts of data is a valuable source of market knowledge. A Business Intelligence (BI) platform was introduced in 2007 to help mine this information to help improve the efficiency and effectiveness of government procurement.

However, like any tool it does have its advantages and disadvantages. As such, we will be exploring ways to help improve current tools and increase the ability to garner insights. Predominantly, we will be exploring network graphs (vizNetwork & tidygraph) using a R shiny application to help visualise the relationships between the Ministries, Agencies and Suppliers. This will be an additional feature which many off-the shelf commercial BI tools are still lacking which could serve beneficial.

Index Terms—GeBIZ, Procurement, Business Intelligence, Network Graphs, visNetwork, tidygraph, R Shiny.

MOTIVATION OF THE APPLICATION

Due to the vast number of quotations & tenders each year, it becomes extremely challenging to track transactional patterns and entities who are involved in each of these contracts. Some of the issues that might have arisen includes:

- Tedious for potential supplier to research past tenders, quotations and period contracts of similar purchases across the entire public sector to determine quotation prices
- Lack of Ministry oversight on how the budgets were spent in the individual sectors and service categories
- Inability to identify reliable suppliers that many agencies and their respective ministries are purchasing from
- Recommend appropriate procurement categories and suggest possible suppliers to invite during the tender notification process

With the provision of GeBIZ procurement data, current analysis is limited to Agencies and Supplies and we will not be able to view the interactions across ministries. Furthermore, information on the type of contracts were also embedded in long text descriptions which makes it difficult to analyse how have budgets been spent.

In view of current constraints, we are motivated to create a dynamic and interactive dashboard to help provide ministries, agencies and suppliers a holistic view on the procurement contracts made thus far.

REVIEW AND CRITIC ON PAST WORKS

The development of Business Intelligence in GeBIZ started in early 2006. GeBIZ BI initiatives can be broadly divided into two areas. The first area entails the development of GeBIZ InSIGHT. It leverages on Machine Learning (ML) techniques to help individual procurement users research historical buys and gain market insights.

The second area covers the development of GeBIZ Management Console (GMC). GMC enables macro-level portfolio management and performance management in the public sector by its features such as filtering, pivot tables, and charts. As mentioned, the existing tools could help gain market insights but there are still ways to help improve how we analyse information with the use of visual analytical techniques. [2]

DESIGN FRAMEWORK

The overview of our approach can be seen in the following figure.



Fig. 1: Overview of the approach

Prior data pre-processing will be carried out to add in the ministry that these agencies belong to. In addition, we will segment the contracts based on their dollar value and topic modelling will also be implemented to determine their respective procurement categories.

With a three–pronged approach, we will help explore how the procurement expenses look like across ministries, agencies and suppliers. We will also investigate if there are seasonal patterns and purchase types specific to an entity. Lastly, we will leverage on the use of network graphs to help us understand their relationships and extract their procurement information at ease with an interactive interface.

Network Visualization



Fig. 2: Visualization by visNetwork

visNetwork was chosen as our preferred library to visualize network relations as it fosters interactivity which a user will be able to appreciate when dealing with complex nodes and edges. However, due to the lack of functions to implement centrality metrices like betweenness, we have made use of *tidygraph* to help us with the implementation and extraction of these additional columns.

In graph theory, betweenness centrality [9] is a measure of centrality in a graph based on shortest paths. A node with high betweenness would mean that it would have more control over the network, because more information will pass through it. With this metric in the procurement context, we would like to identify key suppliers which deals across multiple Agencies.

Definition: Betweenness centrality of a node v is given by

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

Where σ_{st} is the total number of shortest paths from node *s* to node *t*, and σ_{st} (v) is the number of those paths that pass through *v*.

The transition from *tidygraph* to *visNetwork*, however requires us to manipulate our data before it will be compatible for the individual libraries. In tidygraph, we need to ensure that the columns are renamed to "source" and "target" while visNetwork uses "from" and "to". Using <u>dplyr</u>, we can easily perform dataframe manipulation.

As <u>tidygraph</u> also creates a tbl_graph which contains two tibble object where we can use a combination of *activate* and *as_tibble* functions to help extract the node and edge table.



Fig. 3: tbl_graph

Once we have the relevant information, we can create a "Group" column and visNetwork will be able to display these groups as distinct colours. Setting the number of contracts as "value" also help visNetwork plot edges with difference thickness. The thicker the edge, the more contracts that are involved between 2 nodes.

Treemap



Fig. 4: Treemap

Treemap is a powerful way to visualize hierarchical data using nested rectangles. The advantage is that all data can be visualized in a single page utilizing rectangle area for the primary measure, and color for the second measure. Treemaps can be generated by a d3treeR library (https://github.com/d3treeR/d3treeR) in R.

While looking at Procurements, visualizing expenses at the Ministry and Agency level help us identify key spenders. This is useful when we want to know which ministry and which agency in that ministry tend to spend more. We use a Treemap Diagram to visualize the expenses at the ministry Level. The size of the tiles in the Treemap represent the number of orders placed by the ministry and the color indicates the amount spent. In the Sankey, we show the spending at ministry level for its top N agencies and the top N suppliers within each individual agency.

Sankey Diagram



Fig. 5: Sankey Diagram

Sankey Diagram is another effective way to visualize a network graph as flow. The advantage of Sankey Diagram over Sunburst Diagram and regular network visualization is that nodes (and thus node labels) and edges are aligned in line, and the primary measure (count of procurement or monetary value SG\$ in our dataset) represented by edge width can be compared with each other easily. In addition, the second measure can be represented by the color. Sankey Diagram can be generated by Plotly library (https://plot.ly/r/sankey-diagram/) in R.

Latent Dirichlet Allocation

Latent Dirichlet Allocation (LDA) is an example of Topic Modeling technique that enabled us to extract procurements type information from text descriptions. LDA assumes each word in each text sample was chosen from topics which consist of words which have different probabilities to be chosen. Given the number of topics, LDA determines 2 distributions; distribution of words for each topic, and distribution of topics for each text sample. LDA can be run by lda library (https://cran.r-project.org/web/packages/lda/lda.pdf) in R. LDA was used to extract information from the text description column in our dataset. The output of LDA can be visualized on the plane of principal component axes by LDAvis library in R. (https://nlp.stanford.edu/events/illvi2014/papers/sievertillvi2014.pdf)



Fig. 6: Visualized result of LDA

LDA by setting the number of topics to 5 extracted 3 distinct topics (Topic 2, 3, and 5) on the plane of principal components as shown in the above screenshots. Based on the interactive visualized results, the 5 topics were labeled as follows.

Topic 1: Communication (relevant words: invitation, appointment, proposal, request])

Topic 2: Task (relevant words: works, engineering, consultancy, upgrading, building, road])

Topic 3: Product support (relevant words: system, installation, maintenance, testing)

Topic 4: General (relevant words: period, term, month, option)

Topic 5: Public/Organization (relevant words: school, boards, state, departments, organs)



Fig. 7: Calendar plot

The essence to plot a calendar chart requires us to be able to manipulate data time to the necessary formats before we can obtain our desired graph. More importantly, string variables needs to be converted as factors so that weekdays and months could be interpreted as ordinal variables. Using *ggplot2* with its *geom_tile* function, we can visualise the number of procurements across time in a calendar chart. This will help us identify if there are seasonality or cyclical patterns within an agency or supplier. For this example, one of the ministries tend to procure more during the end of the month. This will be useful for suppliers to help prepare for these peak bidding cycles.

2. Stacked Line Chart



Fig. 8: Stack line chart

The stacked plot was created using the *dygraph* library which is a fast, reliable open source JavaScript charting library. Aggregating the number of contracts by month using *dplyr*, we are able to identify trends & proportion of contracts contributed by the individual tenders segments. Upon inspection, a cyclical pattern becomes obvious with a spike in the number of contracts before April, which coincides with the end of the financial year.

DEMONSTRATION – A MOF CASE STUDY

Considering the limitations of current Business Intelligence (BI) tools for GeBiz in place [2], we will place more emphasis on the use of network graph to help identify the hierarchical relationships amongst entitles in this section.

Network Overview



Fig. 9: Network overview

Using Ministry of Finance (MOF) as an example, we will be able to identify its respective Agencies and also their suppliers where they have individually engaged with thus far. This provides an oversight on who the **budgets** were spent on in the individual sectors.

As the chart is interactive, we will be able to drag around the nodes and zoom in to uncover who have made the most number of contracts. Here, MOF - Vital have sent out the greatest number of tenders amongst other agencies from MOF.



Fig. 10: Network involved with MOF

If we are interested to know the details of the tenders MOF - Vital have made, we can filter based on Agency and view the details in an interactive data table below. Sorting by awarded date, we will be able to find out the most recent contracts.

how	10		+ entries	3	Sort		Search:	Search
	X1	П	tender_no.	agency 🔢	tender_description	award_date 1	tender_detail_status	supplier_name
1		3	ACR000ETT14000009	Accounting And Corporate Regulatory Authority	Invitation To Tender For The Provision Of Manpower Services (Facilities Officer) For ACRA	2015-01-28	Awarded to Suppliers	RmaContractsPte.Ltd.
2		4	ACR000ETT15000004	Accounting And Corporate Regulatory Authority	Invitation To Tender For The Provision Of Manpower For Software Testing Services For ACRA	2015-07-01	Awarded to Suppliers	Tescom(Singapore)SoftwareSys
		5	ACR000ETT15000005	Accounting And Corporate Regulatory Authority	Proposed Interior Fitting Out Works for ACRA's Office Space at 10 Anson Road, #05-19 & #05-01/15 (Part) International Plaza, Singapore 079903	2015-04-24	Awarded to Suppliers	MksGlobalPteLtd.

Fig. 11: Sorting and search

The inclusion of the search function also allows us to find out past quotations of similar procurement types. This will help suppliers research past tenders, quotations and period contracts of similar purchases across the entire public sector to determine quotation prices. This will not be made possible without the use of LDA where it has helped us generate a series of procurement types which a tender could belong to.



Fig. 12: Procurement type columns

This is an additional feature which have been added compared to the current BI systems where they use Support Vector machines to predict multi-class labels. Here, LDA provides a probability distribution across topics for 1 observation. This means that a procurement contract could be multi-labelled instead. Now, we can suggest possible suppliers to invite during the tender notification process.



Fig. 13: Filtering by betweenness centrality

With the introduction of the betweenness centrality metric, we will now be able to identify the reliable suppliers that many agencies and their respective ministries are purchasing from. Using the interactive data table, one will be able uncover that Aetos Security Management Pte. Ltd helps with the provision of armed security personnel across government agencies.

Supplier Analysis



Fig. 14: Network involved with a supplier

If we are interested to find out the Agencies that a particular supplier has previously dealt with, we will also be able to do so on the Supplier Network tab. This is essential for Agencies when they would like to evaluate on potential suppliers for the tenders they have put up. This also fosters collaboration across government Agencies where they could garner feedback on these suppliers which aids them in their decisions.

Similarly, a data table have been included below which will react to the filters chosen and provide the details of past contracts if necessary.

DISCUSSION

We presented our work at the Visual analytics Conference and Poster Presentation held in Singapore Management university on 12-Aug 2018. We showcased the various features of our application and received positive comments on the capability of the Application to bring up a Network of people associated with various ministries and suppliers.

Members of the audience were particularly impressed by the Network Visualization and one of them commented on the layout of the network visualization which we had, stating that this was one feature he hasn't seen in other relevant works using the visNetwork package for network visualization. Also, many were amazed at the amount of visualizations possible and the smooth interfacing in R Shiny. The audience were reaffirmed that the whole application has been done in pure R.

FUTURE WORK

1. Fixing the view of vizNetwork

When the betweenness scale is adjusted, the network graph's layout changes and it might be difficult to identify the suppliers who are not well connected. Using igraph's layout, we will be able to fix the layout and adjust the filters in visNetwork. This should make it more intuitive for users when they interact with the graph

2. Enhancement of Supplier Information

In the dataset, information about supplier is only the name. It will be beneficial to add supplier information, such as industry and financial health and performance information such as revenue, gross profit, net profit, and change of stock price.

3. Utilize Information Extracted from Text Description

Utilizing the new columns created based on LDA which indicates whether each procurement order is related to the topic, we can filter out the dataset and analyse the pattern in network for each topic.

4. Enhance Information Extraction from Text Description

The dataset includes text description, and more useful information would be able to be extracted. Tuning of topic modelling can be done by removing more words that disturb the output and trying other numbers of topics and the random seed. Other techniques such as Named Entity Recognition could be helpful as well.

ACKNOWLEDGMENTS

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APPENDIX

I. INSTALLATION GUIDE

1.1 Data Preparation:

- Datasets for upload need to be in .csv format
- The Dataset from GeBIZ needs to be in .csv format and saved in the data folder of the Project under the name "government-procurement-via-gebiz.csv"
- Ensure that the date column in the data is in the format: "yyyy-mm-dd"

1.2 Online Use:

The recommended web browser would be Google Chrome for accessing our application webpage. <u>https://isss608-2017-18-t3-group-17.shinyapps.io/ISSS_608_Group17_ShinyApp/</u>

Besides that, no other special tools are required.

1.3 Local Use:

At the point of the project, R version 3.4.1 and R Studio version 1.1.453 was used to create the application. 1) Install R Studio version 1.1.453 from: <u>https://www.rstudio.com/</u>

2) Download the project folder, unzip it and double click on the R project "ISSS_608_Group17_ShinyApp".



3) Click on the Run App button to run the Application.

II. USER GUIDE

When you launch the App, the first screen that welcomes you will be:

GeViz: Who supplies to the needs of Singapore?									
1.0 Overview	2.0 Import Data	3.0 Data Visualization	4.0 Association Visualization	5.0 View and Export Data					
1.1 About the Proj	ect								
GeBIZ is a governme commerce with the S extremely challengin of the issues that mig	nt-to-business publi ingapore Governme g to track transactio ght have arisen inclu	c eProcurement business or nt. Due to the vast number nal patterns and entities wi des:	entre where suppliers can conduct of quotations & tenders each year no are involved in each of these co	t electronic r, it becomes ontracts. Some					
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In view of current con ministries, agencies a	nstraints, we are mo and suppliers a holist	livated to create a dynamic ic view on the procurement	and interactive dashboard to help t contracts made thus far.	o provide					

The App has 5 main sections. Each section has its own subsections where required. The Layout is as shown.

- 1. Overview
 - 1.1. About the Project
- Import Data 2.
 - 2.1. Select Data for Analysis
 - 2.2. Validate Data
- 3. Data Visualization
 - 3.1. Procurement Expenses3.2. Ministry and Suppliers3.3. Order patterns

 - 3.4. Topic Modeling
- Association Visualization 4.
 - 4.1. Overview
 - 4.2. Supplier Networks
- 5. View and Export Data
 - 1. Overview Page

This page gives a brief introduction to what we are doing in this project.

While we can navigate to different tabs directly from the overview page (As we have incorporated default data), it is recommended that we move to the Import Data page.

- 2. Import Data
- 2.1 Select Data for Analysis



GeViz: Who supplies to the needs of Singapore?

1.0 Overview	2.0 Import Da	ta 3.0 Data Visualization	4.0 Association Visualization	5.0 View and Export Data
2.1 Select Data for Analysis		2 Validate Data		
Select Preferred Data Source				
Default Data S New Data Sou	iource rce			
Next				

In this page, we decide which dataset to use in our analysis. We have 2 options here.

- Use the Default Data (Data that was used for building the app)
 - Suppose we decide to use the Default data source, you can proceed to click the "next" button to navigate to the Validate data section
- Use an updated version of the dataset downloaded from https://data.gov.sg/dataset?q=GeBIZ
 - In case we want to use a new data source, select the "New Data Source" radio button. A new menu will become visible.
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1.0 Overview 2.0 Import E	Oata 3.0 Data Visualization	4.0 Association Visualization 5.0 \	/iew and Export Da	ta		
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	3 ACR000ETT14000009	Accounting Invitation To Tender	2015-01-28	Awarded to Suppliers	RMACONTRACTS	76071.

- In the menu, click on "Browse" button and use the resulting screen to navigate to and select the updated data saved locally in your PC.
- Once it is selected, the app loads it and shows a preview of how it appears. You can use the options to adjust the import until it looks as shown above.
 - Header: Specify whether the dataset contains a header column. (Ideally it should have one.)
 - Separator: Specify what is the separator in CSV file.
 - Quote: Specify the format of quotes in the data.
- o Overwrite Default Data: This option allows you to overwrite the default data with the data you have currently loaded.
- Once the data looks okay, click on the "next" button to navigate to the next page.

2.2 Validate Data

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This page shows you if here were any agencies in your data, that was not able to be mapped onto ministries. You will have to manually find the ministries for these agencies and update the "MinistryReference.csv" file.

If the data looks proper, we can navigate to the Procurement Expenses page in the Data Visualizations tab using the button "Proceed to Visualizations".

3. Data visualization

Viz: Who s	upplies to th	ne needs of Sing	apore?		
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3.2 Procurement Expenses

The section has the procurement related expenses visualized in Tree map as well as Sankey format. The visualizations are under 2 sections

- Amount Spent by Different Ministries
 - Default View is the Color Based on Ministry



• If you Hover over the tiles, the underlying Agency level tiles are visible. If you click on a tile you can zoom in. by clicking on the title, E.g.: "Government.MSF", you can navigate back to the normal view.

Select a Treemap View Color based on Ministry Color based on Agency	Amount Spent by Different Minis OvernmentMSF Proper Association	tries	
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o If you want to see all the agency level tiles at the same time, click on "Color based on Agency".



• If you click on "Show Ministry to Abbreviation Mapping", you can get a pop up screen which shows you the Ministry names and their corresponding abbreviations.

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initial for morning communications and the first of the for	Anistry of Information, Communications and the Arts (MICA)	MICA
Ministry of Law (MINLAW) MINLAW	/inistry of Law (MINLAW)	MINLAW

• Procurements at Individual Ministry Level

- Here, we visualize the flow of cash and number of orders using a Sankey diagram. The controls given help determine the view.
- o By default, it is set to Top N Supplier and Top n Agency and to show the expense amount.
 - We can select a single ministry.
 - We can select the up to Nth top agency to view
 - We can select the up to Nth top supplier to view Procurements at Individual Ministry Level



Procurements at Individual Ministry Level



- We can also choose to visualize by specific Ministry and Agency.
 - We can select the ministry
 - We can select the agency

Procurements at Individual Ministry Level

Toggle View O Top N Agency Supplier Specific Ministry Agency Select a Ministry	Select value to Display Expense Amount Number of Procurements Select Agency
Ministry of Finance (MOF)	Accounting And Corporate Regulatory Authority
	MksGlobalPte.Ltd. PricewaterhousecoopersRiskServicesPte.Ltd.
Ministry of Finance (MOF)	RhtComplianceSolutionsPte.Ltd. Accounting And Corporate Regulatory Authority Deloitte&ToucheEnterpriseRiskServicesPteLtd
	SolutionsatworkPte.Ltd. RhtlawTaylorWessingLlp MciCareerServicesPte.Ltd.

Procurements at Individual Ministry Level

Toggle View	Select value to Display
O Top N Agency Supplier	C Expense Amount
 Specific Ministry Agency 	Number of Procurements
Select a Ministry	Select Agency
Ministry of Finance (MOF)	Accounting And Corporate Regulatory Authority
	Deloitte&ToucheEnterpriseRiskServicesPteLtd
	BdoConsultantsPte.Ltd.
	CertisTechnology(Singapore)Pte.Ltd.
	CleanmagePte.Ltd.
	MilCorearCondeasDia
	Michael Date International
Ministry of Finance (MOE)	Accounting And Comparate Regulations AuthMitGlobalDto Ltd
(Ministry of Finance (MOP)	PricewaterboursecopersManagementSensigesDteltd
	PricewaterhousecoopersPlanageniericGervicesPte.td
	RhtComplianceSolutionsPte Ltd
	BhtlawTaylorWessingl In
	RmaContractsPte Ltd.
	SolutionsatworkPte.Ltd.
	Tescom/Singapore)SoftwareSystemsTestingPteltd
	WizlearnTechnologiesPte Ltd

1.1. Ministry and Suppliers

17_Shiny http://127.00.14797 @ Open in Browser ③	yApp - Shiny	- 🗇 🗙
GeViz: Who supplies to	o the needs of Singapore?	
1.0 Overview 2.0 Import Data 3.0 Data Visu:	alization 4.0 Association Visualization 5.0 View and Export Data	
3.1 Procurement Expenses 3.2 Ministry and Supple	iers 3.3 Order Patterns 3.4 Topic Modelling	
Count of Transactions by Type o	of Tender	
HOE- HIND- H	2000 2000 4000	
Distribution of Tender Amount I	by Ministry	
PMO- ORGSTATE- MTI-	Procurement type	

Count of Transactions by type of Tender •

Count of Transactions by Type of Tender



- •
- O Distribution of Tender Amount by Ministry O This is a box plot of the amounts disbursed in individual tenders.

Distribution of Tender Amount by Ministry



We can zoom in on the values on the left. 0

Distribution of Tender Amount by Ministry

											Proc	curement Type
	PMO -						• •	•	•			
ORG	SSTATE -				•	•				•		0
	MTI-										Ц	Quotations
	MSF-	•				•	•		•	•		Small Value Purchases
	MOT-	4.										Trades
	MOM -	400-				•	•			•	• •	lender
	MOH-	4								•		
E7	MOF-				•	•	•	•				
nis	MOE-		_			-					•	
Ň	MND-	4									-	
М	IINLAW -				• •	•		•				
ħ	MINDEF -					••	• •	•		•		
	MICA -	••••••••••••••••••••••••••••••••••••	000000 0000			•		•	•	•		
	MHA-	He							• •			
	MFA -			• •	•							
	MEWR-	Hel								•		
	MCCY-	4 D	0 00 00					•				
		0e+00										
					Procurem	ent Amo	int					

1.2. Order Patterns

In this screen we explore the variations in procurements over time. Mainly their counts on a weekly and monthly level.



There are 2 visualizations.

•

- Number of Procurements over the Years
 - This one shows the weekly count of tenders issued.

Number of Procurements over the Years



 $_{\odot}$ This can alo be controlled using the panel given

Select a Ministry	
All	
Select Agency	
All	
Select a Supplier	
All	

- Using the above panel, you can select
 - Multiple Ministries
 - Multiple Agencies
 - Multiple Suppliers

0

- Number of Procurements by Type of Tender
 - It shows the number of Procurements split by type on a month level. It is interactive, and you can adjust the slider below the graph for adjusting the view.





1.3. Topic Modeling

.

This Screen allows us to build and visualize the LDA based topic model. As the model building takes more than 6 minutes on average, we have used a previously saved model to visualize. When you are using the default data, there is no action required from the user.

GeViz: Who supplies to the needs of Singapore?

1.0 Overview 2.0 Import Data 3.0 Data Visualization 4.0 Associati	on Visualization 5.0 View and Export Data
3.1 Procurement Expenses 3.2 Ministry and Suppliers 3.3 Order Pattern	15 3.4 Topic Modelling
Generate topic Model	
Topic Model Visualization	
Select Topic Model to Visualize Previously Saved Model	
Vearement bata	
Selected Topic:0 Previous Topic Next Topic Clear Topic	Skide to adjust relevance metric: ⁽²⁾
Intertopic Distance Map (via multidimensional scaling)	Top-30 Most Salient Terms (1)
	8 1.00 2.00 3.00 4.00 4.00 4.00 weight set of the set
	extend annual

In case we want to build and visualize using the current data, click on "Current Data". The system will start generating the model. There is a possibility that the display will not change until the model is generated and visualized.

eViz: Who supplies to the nee	eds of Singapore?	
1.0 Overview 2.0 Import Data 3.0 Data Visualization 4.0 Ass	eciation Visualization 5.0 View and Export Data	
3.1 Procurement Expenses 3.2 Ministry and Suppliers 3.3 Order Pi	atterns 34 Topic Modelling	
èenerate topic Model		
opic Model Visualization		
Hect Topic Model to Visualize Previously saved Model		
Current Data		
ease wait while we prepare the model. Expected duration 5-7 minutes		
current Usta ease wilt while we prepare the model. Expected duration 5-7 minutes elected Topic: Previous Topic Next Topic Clear Topic	Side to adjud relevance metro: ⁽²⁾ ; ; ; ; ; ; ; ;]	
Lurrent vara ease wait while we prepare the model. Expected duration 5-7 minutes sected Topic. Devices Topic Next Topic Clear Topic Intertopic Distance Map (via multidimensional scaling)	Stote to adjust indexence metro: ⁽²⁾	

2. Association Visualization

This section uses network visualizations to visualize the connections between ministry, agency and supplier. 2.1. Overview

GeViz: Who supplies to the needs of Singapore?

elect a Ministry	Network at Ministry Level	
Ministry of Finance (MOF)	•	
elect Agency	Select by id •	
All	Select by group •	
elect a Supplier		Group
All		
elect Betweenness		
* 49 100 107 106 101 104 40 40 1		
		Ministry

Here, the data is visualized at the ministry level. You can use the controls in the side to

- Select the ministry
- Select Multiple agencies in that ministry
- Select Suppliers associated with that ministry.
- To filter based on their betweenness.

The selected data is visible below the graph.

2.2. Supplier Networks

In this page, we visualize the network based on selected suppliers. By using the Controls provided you can add more supplier networks into the graph. The selected data is visible below the graph.

Sample View for Single Supplier:



Sample View for 2 Suppliers:



Sample View of Highlight by Ministry:



3. View and Export Data

This section is for viewing the data used for analysis and saving them to a location in your PC if required.

GeViz: Who supplies to the needs of Singapore?

1.0 Overview 2.0 Import D:	ata	3.01)ata Visualization	4.0 Associatio	n Visualization 5.0 Vi	ew and Export Da	Ita			
ExportData	A	ctive Data					Search:		
		tender_no.	agency	tender_description	award_date	tender_detail_status	supplier_name	awarded_amt 11	ministry
	1	ACR000ETT14000009	Accounting And Corporate Regulatory Authority	Invitation To Tender For The Provision Of Manpower Services (Facilities Officer) For ACRA	2015-01-28	Awarded to Suppliers	RmaContractsPte.Ltd.	76071.21	Ministry Finance (MOF)
	2	ACR000ETT15000004	Accounting And Corporate Regulatory Authority	Invitation To Tender For The Provision Of Manpower For Software Testing Services For ACRA	2015-07-01	Awarded to Suppliers	Tescom(Singapore)SoftwareSystemsTestingPteLtd.	84000	Ministry Finance (MOF)
	3	ACR000ETT15000005	Accounting And Corporate Regulatory Authority	Proposed Interior Fitting Out Works for ACRA's Office Space at 10 Anson Road, #05- 19 & #05-01/15 (Part) International Plaza, Singapore 079903	2015 04 24	Awarded to Suppliers	MisGohaPicLid.	653255	Ministry Finance (MOF)
	4	ACR000ETT15000006	Accounting And Corporate	Provision Of Smart Card Access Control System With Intrusion	2015-06-26	Awarded to Suppliers	CertisTechnology(Singapore)Pte.Ltd.	87690	Ministry Finance (MOF)

You can:

• Select the number of rows to display

- Search for records based on keywords
- Export Data using the export button



Data exported to 'data/Saved/governmentprocurement-viagebiz_export.csv'

By pressing the "Export Data" button, the current data will be saved to File: [Project Folder Path]/data/Saved/government-procurement-via-gebiz_export.csv