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Interactive Narrative Visualization of Global Supply Chain Data

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Introduction

Export / Import is one of the most important economic aggregator. In open economy, all nations intend to go for more export than import to strengthen their economy. The exporting nations try to maximize profit through export and importing nations try to minimize through indigenization of goods and services. However, a right decision at right time by choosing an exporting / importing nation, category of item / department, mode of shipping, optimal period etc. by both exporters and importers are of equal importance. Knowledge about the prevailing trend in the market is also a subject of great value in this economic activity.

Gone are those days when data were kept in hard form, then to computer in spread sheet and were checked by experts taking time for interpretation with error and missing information. Now, data have become as important as that of the business itself. For the quicker understanding and making faster decision, visualization of data has become the more acceptable option and that too with interactive narrative visualization, it has become an absolute necessity among the players in every sector. Export / Import sector being of higher priority for every nation, it is obvious that interactive visualization is of great value that does not need any further elaboration.

I have chosen Global Supply Chain System data that I undertook in one of my Data Exploration Project. Data for the year **2015 to 2018 (4 years)** as was available in the data set, were undertaken for the exploration project. The following findings are taken for the current project of visualization with data considered for top **20 performing nations** from the above data set.

(a) Performance of exporting nations / continents and the trend thereof

(b) Performance of departments, i.e., export categories and the trend thereof

(c) Performance of Shipping Modes and the trend thereof

The following visualizations are created to meet the purpose and make the users understand the trend with ease.

(1) **Animated Line Chart view**

(2) **Interactive Facet Plot view sowing Histogram**

(3) **Interactive Choropleth Map view**

(4) **Interactive Density plot view**

(5) **Interactive Scatter plot view**

My intended audience is general public including research scholars and business community dealing in **export/import sector**.

All the visualizations are created based on the five design sheet methodology that has already been done in another project. Visualizations are done using **R(Shiny)**.

Design

According to my FDS in sheet-4, I included one line chart since its very quick in giving analysis and it's one of the best visual in representing trend of a given time. I decided to put a dynamic visual which will have some animation to make it more appealing and ease of understanding. (Packages Used: **gganimate, ggplot**)

In my 2nd step I undertook more interactivity and categorizing them into more levels. For that I used facet plots and I also used the idea / methodology I used in my five design sheet-5 and sheet-6. But additionally I have created a drop down option which helped me drill down data to multiple items also by incorporating hovering facility I got the information of x and y values which made it more user friendly as well as easy to understand. (package used: **plotly**)

In 3rd step I had to implement a flow map which was the most challenging part of the design process and it was used in all of my five design sheets. It was a huge hurdle for me, since that type of visual with proper annotation and interactivity takes a lot of time to implement, so I had to rule that out because I had to complete my other visuals. I decided to search for an alternative and after extensive trials with different types of maps like **leaflet, ggmap, mapbox** I came across with **highchart maps** which was more interesting. The visual clarity was very good comparing to other visualizations, so finally I implemented that and it is known as choropleth map. (package used: **highcharter**).

In my 4th step I decided to show a different type of visual which will help me to show the distribution for major modes of shipment. I decided to implement a density plot which was very interesting since it provides facility to view all types of shipment mode to understand their distribution. It really gave more clarity on the supply chain process as a whole. (package used: **plotly**)

And lastly I used scatter plot which is a very interesting and dynamic and also had interactivity with proper annotations. (package used: **highcharter**)

Implementation

- The first step I did was to tidy and wrangle the data since this time I used r shiny to implement all my visuals and before it was done partly in R and partly in tableau.

- The whole process of tidy and wrangle was a bit tough and time taking the data set was also huge so I had to limit the data according to my focus area.

- In the data the name of some of the countries were not in English language, so I had to insert the proper name of the countries and for doing that it took a while for me and I had to mutate all the countries with original name using If else functionality. Also I had to add country codes of **ISO3** since it had usage in some of my visuals. (Figure 1 & Figure 2)

Figure 1

```
supply<- supply%>% mutate(Date=mdy_hm(order.date..DateOrders.))%>% filter(Order.Country  %in%
c("Estados Unidos", "Francia", "México", "Alemania", "Brasil", "Australia","Reino Unido",
"China", "Italia", "India","Japón","Canada","Bélgica","España","Hong
Kong","Vietnam","Chile","Argentina","Dinamarca","Rusia","Singapur"))%>%
  select(- one_of(col_remove))
dim(supply)


supply<- supply%>% mutate(Order.Country= case_when(Order.Country=="Estados Unidos"~"United
States of America",Order.Country=="Francia"~"France",Order.Country=="México"~"Mexico",Order.C
ountry=="Alemania"~"Germany",Order.Country=="Brasil"~"Brazil",Order.Country=="Reino
Unido"~"United Kingdom",Order.Country=="Italia"~"Italy",Order.Country=="Japón"~"Japan",Order.
Country=="Bélgica"~"Belgium",Order.Country=="España"~"Spain",Order.Country=="Dinamarca"~"Denm
ark", Order.Country=="Rusia"~"Russia", Order.Country=="Singapur"~"Singapore",
Order.Country=="India"~"India",Order.Country=="Argentina"~"Argentina",Order.Country=="Chile"~
"Chile",Order.Country=="China"~"China",Order.Country=="Australia"~"Australia",Order.Country==
"Hong Kong"~"Hong Kong",Order.Country=="Vietnam"~"Vietnam",Order.Country=="Canada"~"Canada"))
```

Figure 2

```
library(countrycode)
supply$continent <- countrycode(sourcevar = supply$Order.Country,
                                origin = "country.name",
                                destination = "continent")
supply$iso3<-countrycode(sourcevar = supply$Order.Country,
                                origin = "country.name",
                                destination = "iso3c")
```

- The most important aspect of all these was to integrate all the visuals in r shiny. So Initially I tried putting all the visuals without any layout and that didn't go well so I had to change my plan and started searching for good organized layouts and eventually I came across shiny app gallery and chose a template from it **(https://shiny.rstudio.com/gallery/soil-profiles.html)** after that I started implementing all the plots.

- The first visual was made through using ggplot and gganimate package function and rendered in server. For every visual I used fluid row embedding since it was segregating the plots properly according to the size of the page and also used box as a background for all the narrative visuals.

- The next visual was created using facet plots by using facet wrap and I added interactive select input into it.
- The 3rd one was highchart choropleth map and for implementing it I had to first install the highcharter package and joined the iso3 table with one of my dataframes to start making it. Initially I was having a lot of challenge in implementing it, since the code is bit tricky and I had to use one of the website(**https://code.highcharts.com/mapdata/**) of Jason file for linking and joining it.

- In the 4th visual I tried showing the distribution of modes of shipment which also had interactivity, but the challenge was to position it so here also thankfully fluid row helped me in adjusting the visual in place.
- And the last visual was an interactive scatter plot this visual is also implemented using high chart and it looks very good as well as it is easily understandable.

- Apart from all of this there was another upheaval task that is to put an appropriate header background image. For that a struggled a lot in the beginning but then I searched many examples and found a suitable 1 from r-studio community.(**https://community.rstudio.com/t/using-image-as-full-background-of-headerpanel-in-shiny-app/28601**)

User Guide

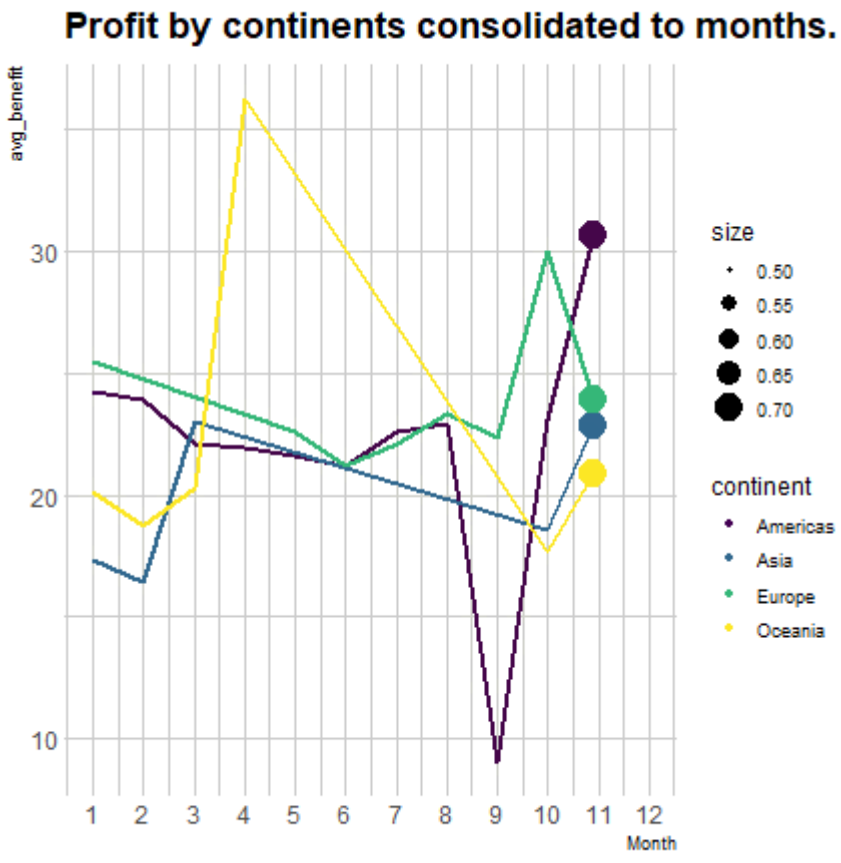
There are five different visuals created for the users for understanding the pattern and trend in general and understanding of the objectives in particular as mentioned in the introduction. In the R-shiny platform we have used two panels: panel1 & panel2.

- **Panel1** has 2 visualization namely **Animated Line Chart view(**fig1**)** & **Interactive facet plot view(**fig2**).**

- **Panel2** has 3 visualizations namely **Interactive Choropleth Map view(**fig3**),** **Interactive Density plot view(**fig4**)** & **Interactive Scatter Plot view(**fig5**).**

1. **Animated Line Chart view**:

Figure 3 fig1



The line chart is so prepared that it provides the automated animated view of performance in terms of profit by continents consolidated to months. Here the data pertaining to average profit from the year **2015 to 2018 by top 20** performing countries are consolidated month wise. The average profit data pertaining to continent for the month of January for the years **2015 to 2018** are consolidated and similarly for the month of **February, March etc. Months** are shown along X-axis and the average profit figures are shown in Y-axis. As per data, four continents are considered, which are:

Oceania (color code yellow),

Europe (color code green),

Asia (color code blue),

Americas (color code violet).

- At the onset, the automated animation starts from month 1 and the line diagram of 4 continents moves on at a pace making it very easy to understand the pattern, and when the lines reach month **of December i.e., 12**, the movement stops for a fraction of second and again repeats the dynamic animation without any intervention from viewer. On observation, it is revealed that Asia starts with a negative growth from **Jan to Feb (from 17.5 to 16)** and then rises steeply to **23.5 in March**. Again its export profit falls linearly to **19 in October and thereafter rises to 25 by December**.

- Oceania also starts with a dip from **20 to 19** by **February**, but, then rises very steeply to its maxima of **36 in 2 months** and again fallback to **18 in October**. But again it rises to **21 in Nov** and then falls back to **19 in December**.

- Americas started from just below **25** and maintained status for **1 month**, but then fell to **22.5** and maintained same status till month of June, then rose back to **23** in august, but then fell sharply to **9** in September. But again rose steeply to 31 in November and finally fell to **25** in December.

- Europe started with just above **25** and fell gradually to **21.5** in June and again rose to 30 in October to finally fell to **24** in December.

- The visualization points to the fact that profit is not evenly distributed neither among the continents nor among the months.

2. **Interactive facet plot view**:

Figure 4 fig2

- The second visualisation is the interactive one that shows the facet of histograms region wise. The profit is shown in **Y-axis and years are shown in X-axis. The departments**, i.e., the export category of goods are provided in drop down, which the user can change and find the detail scenario pertaining to the selected one.

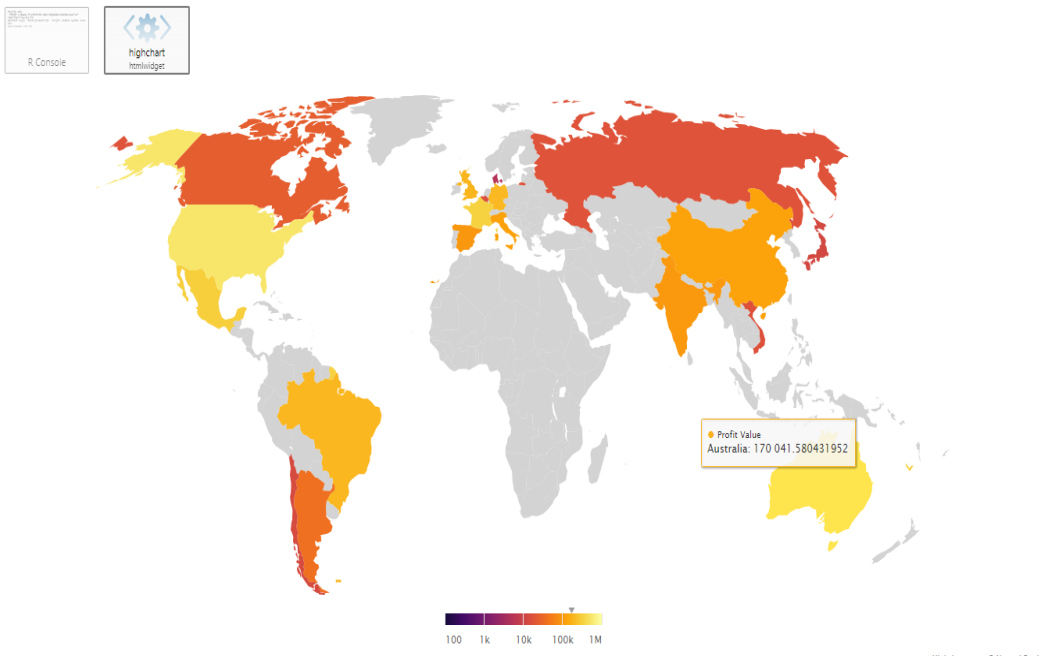
- The interactive visual is so clear and transparent that any ordinary viewer can also understand the status of every department region wise. The regions as per the data considered are: **Canada, Central America, East of USA, Eastern Asia, Eastern Europe, Northern Europe, Oceania, South America, South Asia, South of USA, Southeast Asia, Southern Europe, US Centre, West of USA, Western Europe etc.**

- From the visual it is clear that for any department, the profit is not distributed evenly neither for the years nor for the regions. Those who are in the business of export/import can make use of this visualisation for taking right decision to choose the department or region or both.

- Furthermore, by putting the cursor on any histogram bar, the details pertaining to year, total benefit, input departments are displayed in the box.

Figure 5 fig3

3. **Interactive Choropleth Map view**:



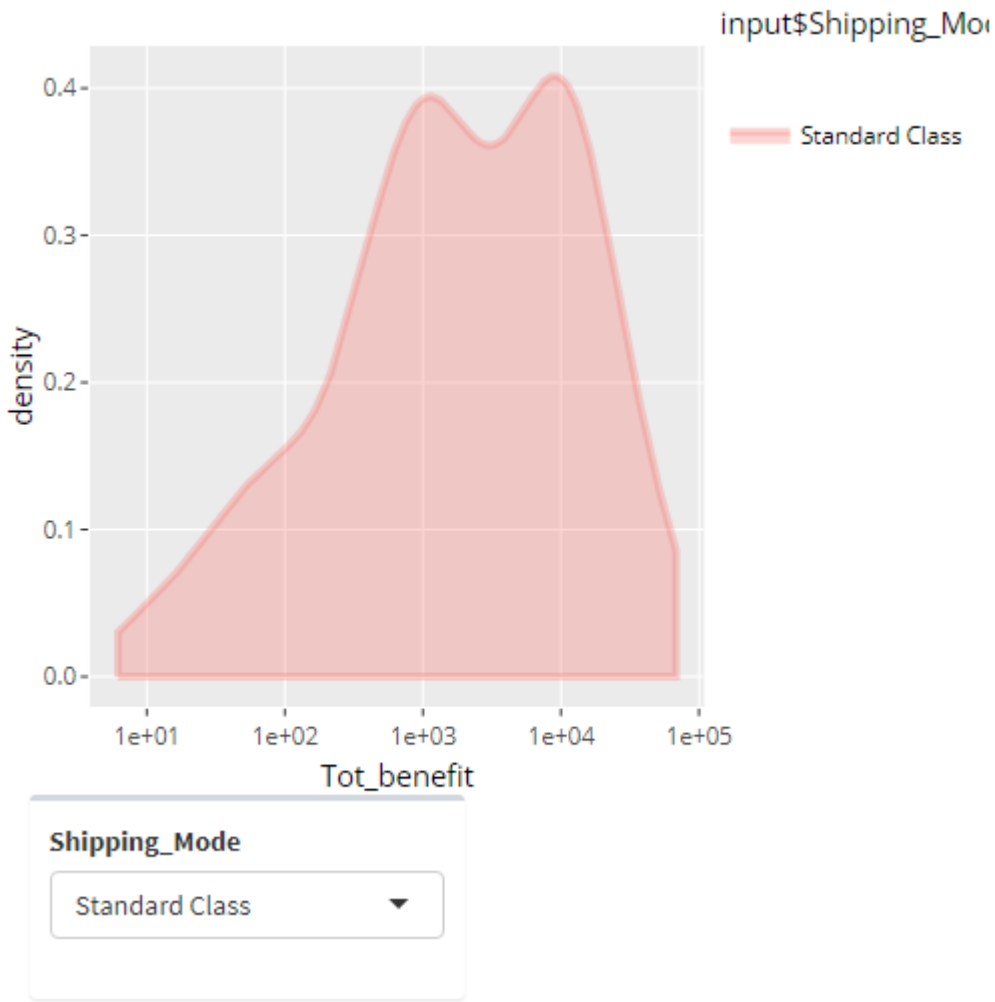
- This is one of a new addition in the plot types, where the profit margins in the range of 100, 1000, 10000,100000, 1000000 are depicted through colours.
- The deeper the colour lesser the profit and lighter the colour higher the profit value. Accumulated profit from the year **2015 to 2018** are displayed on the global map where the countries are shown in default colour.

- The interaction is effected with the movement of the cursor by the user/viewer. On placing the cursor on the country of interest, the colour is automatically changed according to its accumulated profit margin. Also, the tool tip box displays the name of the country and the profit value. This kind of visualisation is particularly useful to have a

global view at a glance requirement situation. From this view it is clear, that countries have different accumulated profit and a sense of competition is sensed.

4. **Interactive Density plot view**:

Figure 6 fig4



- In this visual, shipping mode (interactive) mode wise benefits are displayed with the help of density plot. In Y-axis, the density is shown, where as in X-axis, the profit figures are shown.

- The drop down menu provided for the user / viewer interaction. User/viewer can change the shipping mode from the drop down menu. Once changed from the default mode, the changed density plot is displayed.

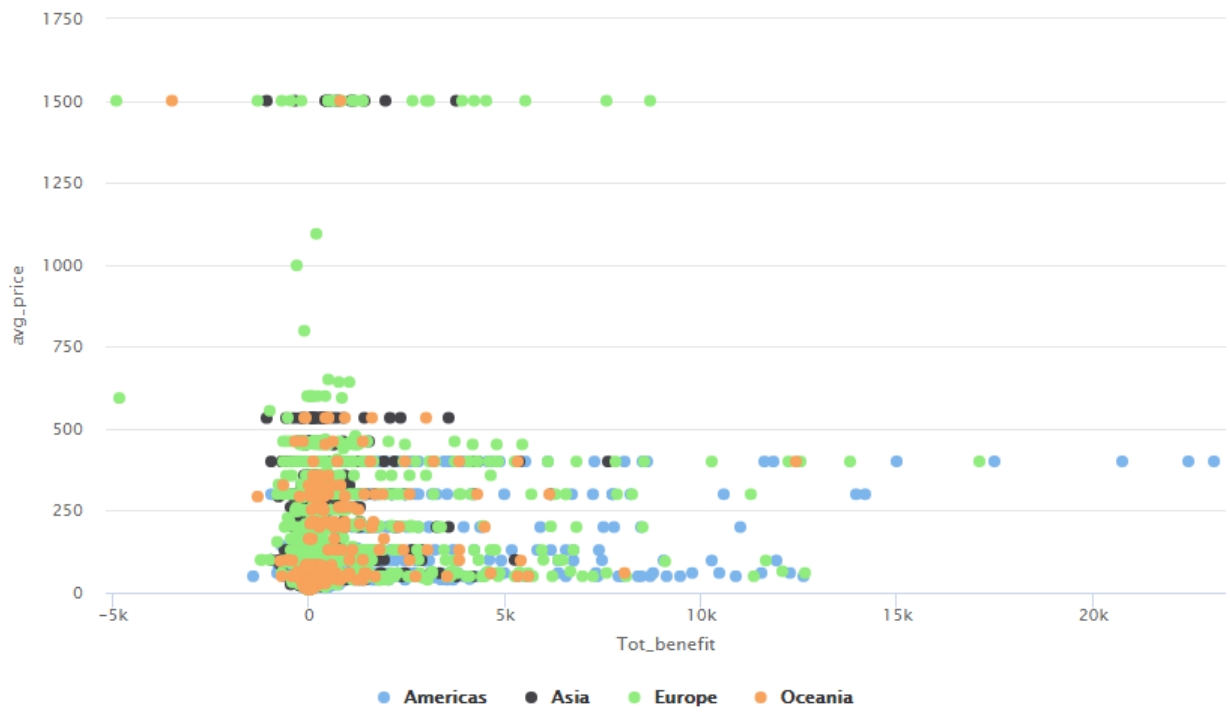
- With the further interaction of movement of cursor, the tool tip view provides the figures of density, total benefit and the shipping mode.

- From the visual, it is clear that, the maximum profit registered for **shipping mode of standard class**, which is quite normal.

- Most shipment happens through **Standard class**, as it is cost effective and its efficiency level is also higher than others. This view is an eye opener for the exporters / importers.

5. Interactive Scatter Plot view:

Figure 7 fig5



- The visual shows Average price of the products being transacted by the exporting nations in Y-a is and in Total Benefit in X-axis.

- The four continents are marked with different colours. As interactive action, the user can click on any continent out of the four **Americas, Asia, Europe and**

Oceania. On selecting one continent, the colour of dots inside the graph area, changes to its own colour, i.e., the countries of the continent are made visible.

- But clicking once more to the continent, displays the dots of colours of all other continents. The further interaction happens when the user / viewer puts the cursor over the region in the plot.

- A tool tip box shows the **average price of products transacted, total benefit, the continent name.**

- This visualisation is useful in viewing / monitoring the export trend in the market.

Note: - As the applications have image output it may take some time to fully load in the server. Users/Viewers are requested to keep patience please.

Conclusion

As is evident, that, the export business is highly competitive. There is no country which can claim absolute majority in the market. However, there is plenty of scope for further improvement. The interactive visuals are being self-explanatory, are very effective in assessing the market trends, profit-booking, shipment mode performance and or, export category performance. The visualisation are so effective and easy to use, it provides facility to make decision on the basis of information in the visuals, without even going for any data repository or paper figures etc.

The challenges in design process is experienced in finalising all the visuals. Related packages were not available readily. Research with google search and other sites had to make. The designs prepared had to be tested for checking their acceptability. The project being a solo project, I had to invest more time to complete. Nevertheless, it was very interesting and I enjoyed throughout as because it was challenging.

Finally, to conclude, I would like to point to the fact that, the days of narrative interactive visualisation has arrived and data analytics work would be incomplete if it is not used and the users also may not like otherwise. The utility of this kind of visualisation is on the rise and I am sure that the visualisation as provided in the current project will be useful for my targeted audience as well as by others.

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- https://jkunst.com/highcharter/
- https://stackoverflow.com/

Appendix

Five Design Sheets:

Figure 8 Sheet-2

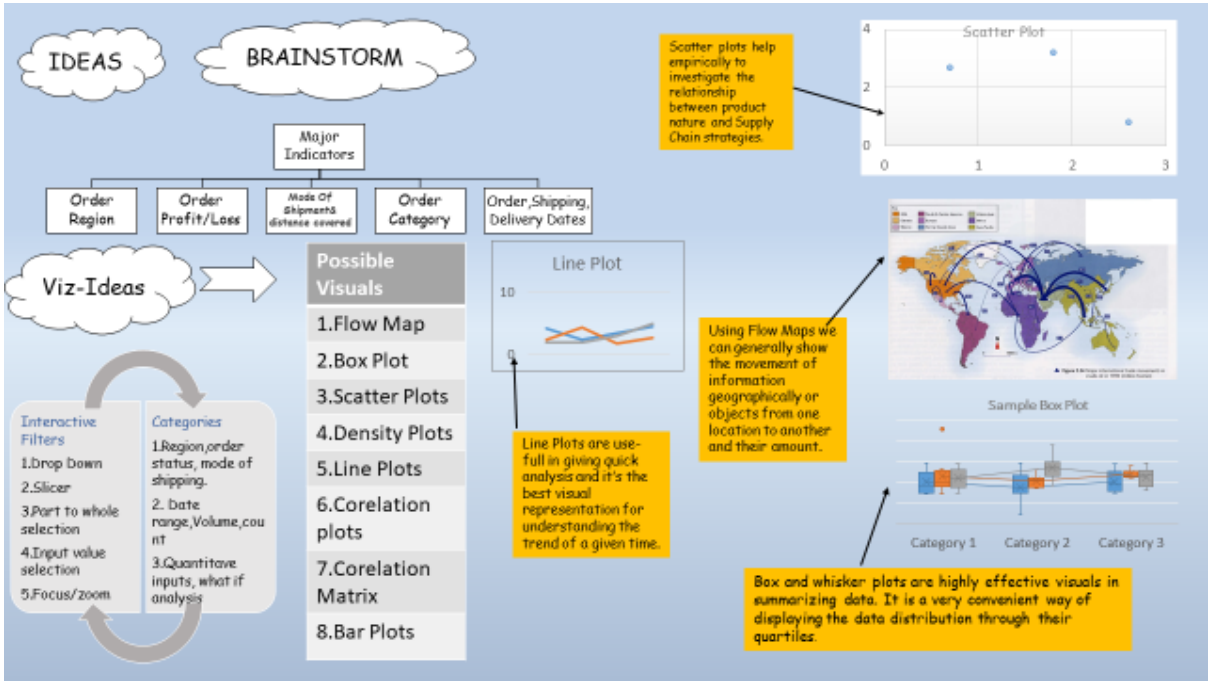

Figure 9 sheet-3

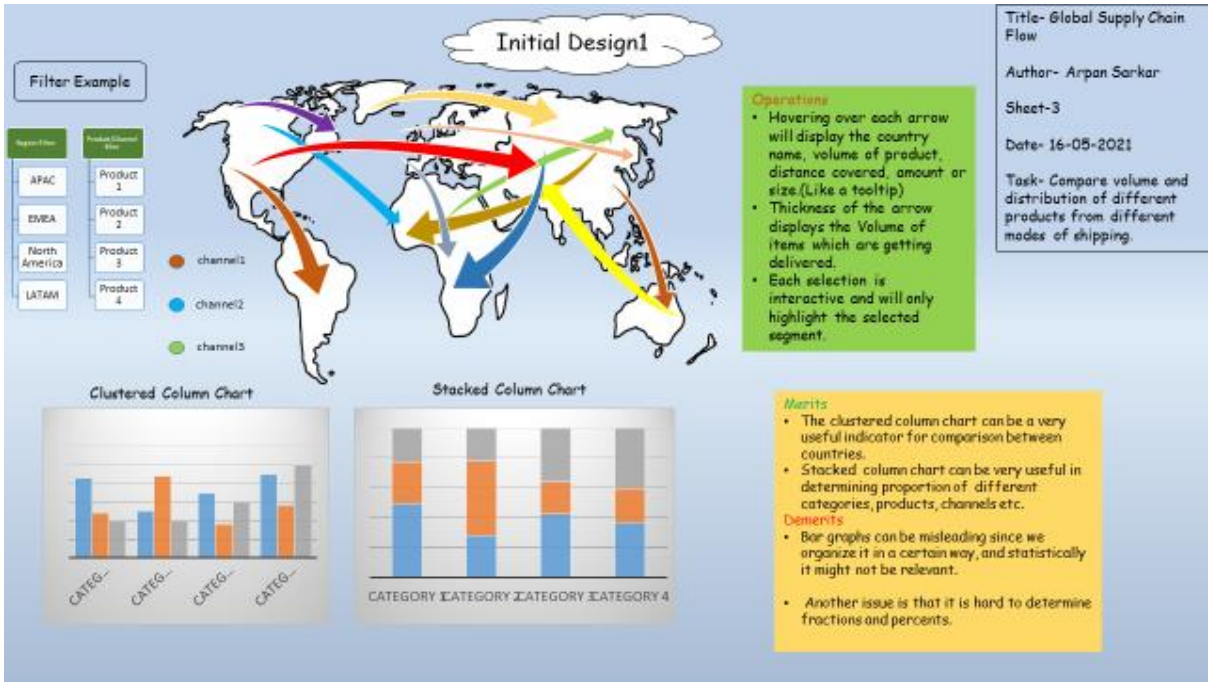

Figure 10 sheet-4

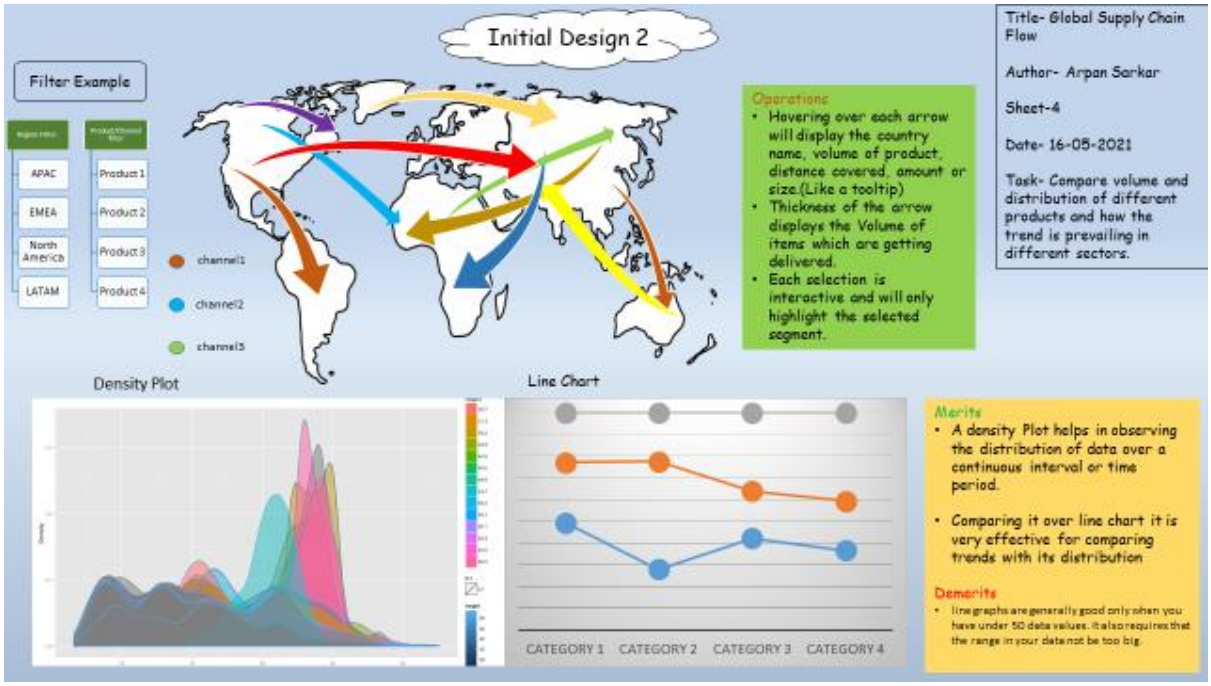

Figure 11 sheet-5

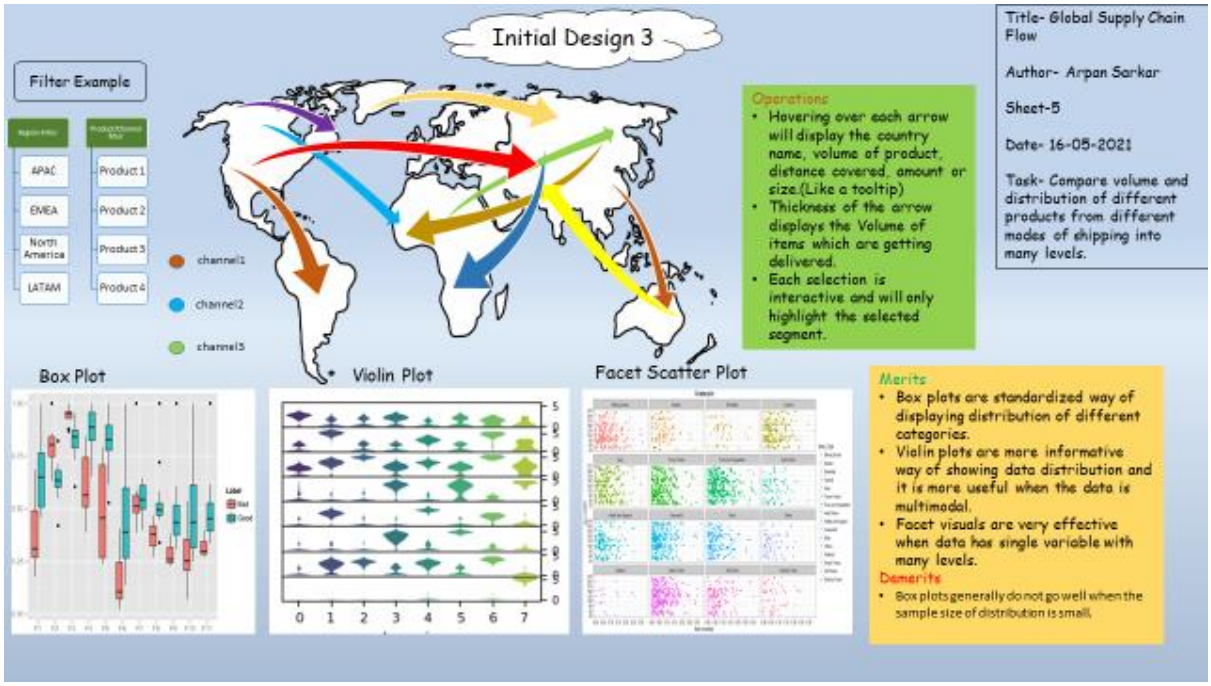

Figure 12 sheet-6