

# Empowering Supply Chain Analytics during the Post-Pandemic Recovery using Power BI

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Received on 06/06/2022; revised on 10/21/2022; published on 10/23/2022

## Abstract

The post-pandemic world has exposed companies' various weaknesses in the supply chain strategy, such as product shortages, loss of revenue, high transportation costs, reputational damage, and increased competitive pressures. These manufacturing and logistical constraints have necessitated an expedited manner to generate a visualization dashboard to allow supply chain management executives to exercise rapid, more accurate, and agile decision-making. The utilization of a business intelligence tool such as Microsoft Power BI increases with industries compared to the conventional data analysis tools, which are splintered and are tedious in consolidating data unable to produce interactive dashboards. This paper demonstrates supply chain data acquisition, cleanup, transformation, and at-a-glance visualizations leading to interactive performance dashboards providing actionable supply chain management insights utilizing the Microsoft Power BI tool for effective decision-making. Results display the power of data visualizations that accelerate and optimize various supply chain processes, thereby giving companies a competitive advantage using Power BI in place of other conventional analytical tools during the post-pandemic crisis. The proliferation of the Power BI tool in supply chain management will allow decision-makers to harness the complex data and produce descriptive and actionable business insights in an industry marred by shortages and delays.

*Keywords: Business Intelligence, Visualization, Power BI, Supply Chain Management, Insights*

## 1 Introduction

The COVID-19 pandemic caused a seismic shift in how we operate our businesses, especially the functioning of the supply chain management (SCM). SCM was impacted in almost all industries. Nearly two years later, companies have not fully evaluated the disruptive shocks in the post-pandemic world. The aftermath of prolonged lockdowns in many countries directly impacted the ability to fulfill customer demand due to manufacturing restrictions and skyrocketing global transportation costs. The new urgency for SCM and traditional analysis tools cannot cope up with the challenges of this urgency. Use of business intelligence tools makes it easier to manage inventory by providing a visual reference for current inventory levels and pending orders. This makes it easier to forecast inventory needs and set reorder points. One can also visualize the movement of goods and material throughout the supply chain into your inventory and out the door to customers. Data analytics has the ability to provide valuable insights (Desouza and Jacob, 2017; Fosso Wamba et al., 2015; Janssen and Kuk, 2016; Kyriazis et al., 2020; Palma-Ruiz and Gómez-Martínez, 2019). Latest Business Intelligence (BI) tools like Microsoft Power BI allow supply chain decision-makers to harness complex data to produce predictive business insights compared to conventional data analysis tools like Microsoft Excel.

Today, businesses operate in a “big data” world, and data visualization techniques play a critical role in distilling critical insights from otherwise complex information.

Microsoft Power BI tool can help businesses collect and transform global transportation costs into insightful, decision-driven visualizations. The Power BI tool offers excellent features to visualize quantitative data. A “big data” world surrounds business, and data visualization techniques play a critical role in distilling critical insights from otherwise complex information (Shin, D. H., & Choi, M. J. (2015). Segel et al. (2010) and Singer's (2011) studies reported that different charts and graphs drive a higher user-driven and engaging experience of statistical information. Typically, the traditional tools such as Microsoft Excel could not deliver the same user-driven impact.

This research study utilizes the Power BI tool to produce powerful visualizations of global containerized freight costs in the post-pandemic world caused by pandemic crises to drive actionable SCM business insights.

The methods section explains the procedure followed in this research starting from data acquisition to creating interactive visualizations. The results and discussion section presents screenshots of the Power BI visualizations and discuss the insights obtained, followed by the final closing statements in the conclusion section.

## 2 Literature Review

### 2.1 Post-Pandemic World and Supply Chain

The post-pandemic world has posed many challenges for all types of businesses. Revenue losses due to the pandemic might take years to recover (Reeves, Lang, and Carlsson-Szlezak 2020), and businesses must utilize data to drive inventory replenishment and manage global transportation costs most efficiently. The challenge for the supply chain business is to be able to make their supply chains more resilient without weakening their competitiveness. To meet that challenge, SCM needs to understand their vulnerabilities and then consider measures and procedures which would lead to a more robust and intelligent system.

SCM disruptions are common, but they often impact different industries or elements at different times for diverse causes (Chopra, S., & Sodhi, M. (2014). Previous SCM disruptions, including natural disasters, terrorist attacks, economic tariffs, regulations, and political restrictions, helped businesses learn how to operate and mitigate such risks. Craighead et al. (2020) reported the differences between different supply chain disruptions. The study highlighted how the Covid-19 pandemic forced global supply chain management "to think in new and unfamiliar ways."

### 2.2 Microsoft Power BI Tool

Wright, C. Y., & Wernecke, B. (2020) defines Microsoft Power BI as a business analytics tool that enables harnessing, transformation, and visualizing data in an accessible manner. Power BI tool facilitates smarter, agile reporting of complex data in a visualized form. Visualizing data offers better digestion of complex data, and decision-makers can easily interpret results-driving proactive decision making. Power BI offers statistical tools like R and features artificial intelligence capabilities to introduce predictive forecasting. The powerful Power BI tool has been used across different industries, including non-for-profit decision-making. Sharma B. (2020) study displays how business intelligence tools can better visualize the exploitation practices of the endangered species as a critical step in regulating the buying and selling of the 'nearly extinct' wild fauna and flora.

Today, analytics and business intelligence (ABI) technology is helping many businesses survive and become more agile and data-savvy, especially while navigating unprecedented global challenges like the post-pandemic world and the 21st Century information overload. Historically, ABI was seen as a contributor to business success, but now, it is the foundation of every organization (Wixom, B., & Watson, H. (2010). ABI applications like Microsoft Power Business Intelligence tool rose to prominence as a critical driver for solving complex business decisions (Yoon et al., 2014). Microsoft Power BI tool uses advanced algorithms to transform large amounts of data into insightful data visualizations.

## 3 Methods

### 3.1 Technique used

This study used descriptive analytics techniques to illustrate how the costs of the global containerized freight industry have drastically increased in the post-pandemic world. The focus of this research was exploratory since it is intended to explore and highlight the Year-on-Year percentage containerized freight rate change by destination and container size and the

twelve-month containerized freight rate tracker by destination and container size.

### 3.2 Data Collection

Dataset used in this analysis was acquired in the form of a CSV file from the database (www.sharcx.com, 2022). The dataset for the analysis is part of a sample dataset. All the records (N = 430) were used. The dataset contains ten years (2012-2022, inclusively) of international containerized freight costs data from one geographical origin in Central China (Shanghai) traveling to two geographical destinations to the US West Coast (Los Angeles) and the U.S. Mid-West (Chicago via LA-LB). Data were provided at 1-monthly time intervals and with average containerized freight costs per destination in \$ US Dollar Rate. Data were cleaned, transported into the Power BI tool, and analyzed by destination, by size of containers to establish actionable visualizations for supply chain management during the post-pandemic crisis.

The columns shown in Figure 1 represent the following: Year and Month columns represent the year and month in which containerized freight costs were charged; the next column is Container Size specifying the costs broken down either for 20ft container or 40ft container; the column Origin indicates the starting location of containers shipments; the column Destination represents the final geographical distance of containers; the \$ USD Rate column represents the average actual cost of each container; followed by last two columns of Date and Month number in which containerized freight costs were charged. Extract, transform and load (ETL) procedures are carried out to create powerful visualizations using the Power BI tool.

Year	Month	Container Size	Origin	Destination	\$ USD Rate	Date	Month No
2012	Jan	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	590	Sunday, January 1, 2012	1
2012	Feb	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	590	Wednesday, February 1, 2012	2
2012	Mar	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	680	Thursday, March 1, 2012	3
2012	Apr	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	740	Sunday, April 1, 2012	4
2012	May	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	680	Tuesday, May 1, 2012	5
2012	Jun	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	700	Friday, June 1, 2012	6
2012	Jul	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	670	Sunday, July 1, 2012	7
2012	Aug	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	650	Wednesday, August 1, 2012	8
2012	Sep	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	620	Saturday, September 1, 2012	9
2012	Oct	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	650	Monday, October 1, 2012	10
2012	Nov	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	660	Thursday, November 1, 2012	11
2012	Dec	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	680	Saturday, December 1, 2012	12
2013	Jan	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	660	Tuesday, January 1, 2013	1
2013	Feb	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	640	Friday, February 1, 2013	2
2013	Mar	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	760	Friday, March 1, 2013	3
2013	Apr	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	760	Monday, April 1, 2013	4
2013	May	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	750	Wednesday, May 1, 2013	5
2013	Jun	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	770	Saturday, June 1, 2013	6
2013	Jul	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	770	Monday, July 1, 2013	7
2013	Aug	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	800	Thursday, August 1, 2013	8
2013	Sep	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	760	Sunday, September 1, 2013	9
2013	Oct	20ft container	Central China (Shanghai)	U.S. West Coast (Los Angeles)	760	Tuesday, October 1, 2013	10

Fig. 1. International Containerized Freight Costs Dataset between January 2012 – January 2022. (Sample shown)

### 3.3 Method Steps

- (1) Acquisition of a dataset from www.sharcx.com (2022).
- (2) It is necessary to login to Power BI or use the Power BI Desktop to build a dataset using an Excel spreadsheet.
- (3) On invoking Get Data, it gives various options to get data ranging from content packs to online services. The clear option for us is to connect to "Excel workbook". It prompts a user to select the CSV database saved either locally or online.
- (4) The importing process of the chosen database takes only two minutes to complete, and Power BI will automatically link and upload the data into the Power Query Editor.

- (5) The importing process of the chosen database takes only two minutes to complete, and Power BI will automatically link and upload the data into the Power Query Editor.
- (6) Clean the dataset in the Power query editor section. The process of cleaning data includes formatting of dimensions or deleting bad data. Each dimension of the dataset must be set up with the right formatting option. The formatting options include either text, decimal place, fixed decimal number, whole number, date/time, or date format to allow other Power BI analytics software to process and better visualize the data in the form of graphs and trend analysis. Additional step includes renaming columns to a desired name. Power query editor tracks all the applied steps to the right of the screen under Query Settings, see Figure 2. Query Settings with applied steps are one of the very powerful features of Power BI. Users can track and monitor previous steps and revise as needed.

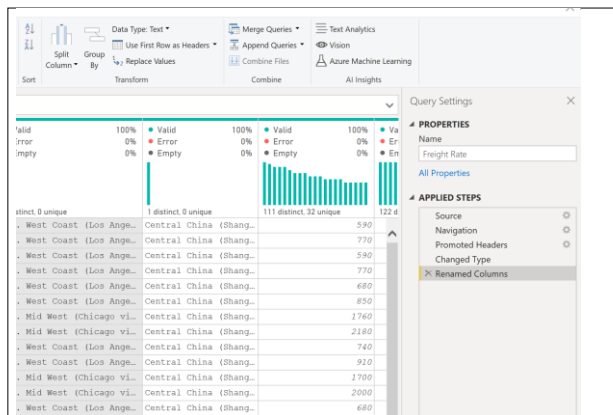


Fig. 2. Query Settings with applied steps. (Sample shown)

- (7) Click on ‘Close & Apply’ in the power query editor and the cleansed data will be transported into the Power BI report level. Users can build visualizations only at report level and only once the data is prepared and cleansed.
- (8) Once the data are transported into the report level, in the middle of the screen, users will see a blank/white canvas and on the right, a menu of pre-built Visualizations, Filter and Field options which could be used to build a report. In this study, first we create a date filter visualization to allow users to control for the date range as needed. The process of creating a report through visualizations is simple and fast. Click on the Filter visualization and drag Date dimension into the field option of the visualization.
- (9) The date filter visualization includes many options of how the date can be displayed, which enhances users experience. The choice of Date filter includes selection of either Between, Before, After, List, Dropdown, Relative Date or Relative features. In this study, we select Relative feature and adjust the date selection to include ‘Last 40 months (Calendar)’, which represents date filter spanning from February 2019 – January 2022.
- (10) Secondly, a second filter visualization is added to control for the size of containers. This option will allow users to improve their experience and customize the reports based on their needs.

- (11) Build a customized column by clicking on the ellipsis “...” located on any of the field dimensions on the right, in the Field menu. The customized column is built to list the size of containers without the inclusion of text “container” using data analysis expression formula (DAX). The DAX formula is written as follows:  $Size = \text{if}(\text{Freight Rate}[\text{Container Size}] = "20\text{ft container}", 20, 40)$ . This process can be completed at the Editor level or at Report level in the Power BI desktop version. The option is voluntary, this study builds it at the Report level.
- (12) Build a second customized column to concatenate Destination & Size dimensions using the following DAX formula:  $\text{Destination / Container Size} = \text{Freight Rate}[\text{Destination}] \& " - " \& \text{Freight Rate}[\text{Size}]$ . This new dimension called ‘Destination / Container Size’ will be used in the Line Chart Visualization, explained in Step 12.
- (13) Next, select Line chart visualization from the menu of pre-built Visualizations on the right. Add the Date dimension on the X-axis, average \$ USD containerized freight costs (\$ USD Rate) on the Y-axis and add Destination / Container Size dimension to Legend field. The line chart visualization displays the average containerized freight costs by a 1-monthly date interval, expressed in \$ US dollars, by container size and by destination. All containerized freight costs data are tracked from Central China (Shanghai) to two separate geographical destinations: the U.S. Mid-West (Chicago via LA-LB) and the U.S. West Coast (Los Angeles).

(14) Figure 3 displays how a quick DAX measure can be built to calculate the percentage change in Year over Year of average containerized freight costs (\$ USD Rate YoY %). Power BI tool helps you to calculate the formula automatically by using the quick measure features. The outcome of DAX formula is:

```

$ USD Rate YoY % =
IF(
    ISFILTERED('Freight Rate'[Date]),
    ERROR("Time intelligence quick measures can only be grouped or filtered by the Power BI-provided date hierarchy or primary date column."),
    VAR __PREV_YEAR =
        CALCULATE(
            AVERAGE('Freight Rate'[$ USD Rate]),
            DATEADD('Freight Rate'[Date].[Date], -1, YEAR)
        )
    RETURN
        DIVIDE(AVERAGE('Freight Rate'[$ USD Rate]) - __PREV_YEAR, __PREV_YEAR)
    )
    
```

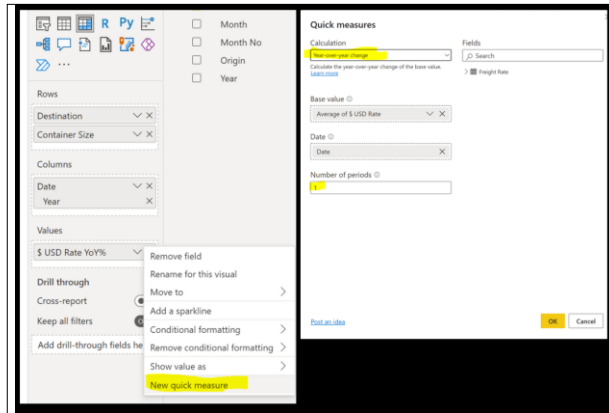


Fig. 3. Build a new quick measure with Power BI pre-determined DAX formulas (Sample shown)

- (15) Build a second quick DAX measure to calculate the \$ US dollar absolute variance change in Year over Year of average containerized freight costs (\$ USD Rate YoY \$). Power BI tool helps you to calculate the formula automatically by using the quick measure features. The outcome of DAX formula is:

$$\begin{aligned}
 & \$ USD Rate YoY \$ = IF( \\
 & \quad ISFILTERED('Freight Rate'[Date]), \\
 & \quad ERROR("Time intelligence quick measures can only be grouped or filtered by the Power BI-provided date hierarchy or primary date column."), \\
 & \quad VAR __PREV_YEAR = \\
 & \quad \quad CALCULATE( \\
 & \quad \quad \quad AVERAGE('Freight Rate'[$ USD Rate]), \\
 & \quad \quad \quad DATEADD('Freight Rate'[Date].[Date], -1, YEAR) \\
 & \quad \quad ) \\
 & \quad RETURN \\
 & \quad \quad AVERAGE('Freight Rate'[$ USD Rate]) - __PREV_YEAR \\
 & )
 \end{aligned}$$

- (16) Select Matrix table visualization from the menu of pre-built Visualizations on the right. This Matrix table is designed to measure the percentage change in Year over Year of average containerized freight costs (\$ USD Rate YoY %). In the Rows add Destination, Container Size, under Columns add Date: Year, and under Values field add the two recently created DAX measures: \$ USD Rate YoY % and \$ USD Rate YoY \$. Customize colors accordingly.
- (17) Build a third quick DAX measure to calculate the percentage change over the past Three Years of average containerized freight costs (\$ USD Rate 3-YoY %). Copy the previous DAX formula \$ USD Rate 3-YoY % and replace '-1' with '-3' and rename the DAX measure to (\$ USD Rate 3-YoY %).
- (18) Repeat the above step for a fourth quick DAX formula by copying DAX measure of \$ USD Rate YoY \$ and replace '-1' with '-3' and rename the DAX measure to (\$ USD Rate 3-YoY \$).
- (19) Select and build a second Matrix table visualization from the menu of pre-built Visualizations on the right. This Matrix table is designed to measure the percentage change over the past Three

Years of average containerized freight costs (\$ USD Rate 3-YoY %). In the Rows add Destination, Container Size, under Columns add Date: Year and under Values add the two recently created DAX measures: \$ USD Rate 3-YoY % and \$ USD Rate 3-YoY \$. Customize colors accordingly.

- (20) Add conditional formatting to the Matrix table results, to visually express the change in percentages to drive a decision-making process.
- (21) Lastly, build a fifth quick DAX measure to calculate the average \$ US container cost per Ft as follows:
 
$$\text{Cost per Ft} = \text{divide}(\text{average}('Freight Rate'[\$ USD Rate]), \text{average}('Freight Rate'[Size]))$$
- (22) Select and build Ribbon chart visualization from the menu of pre-built Visualizations on the right. This Ribbon chart visualization is designed to measure the \$US Cost per Ft. In the X-Axis add Container Size, under Y-Axis add measure \$US Cost per Ft, under Legend add Destination and Small Multiples add Date-Year dimension.
- (23) Finally, save your work.

## 4 Results and Discussion

Meaningful supply chain management insights about the international containerized freight costs were revealed to aid fast decision-making through use of Power BI visualizations (screenshots shown in the following figures).

This study used descriptive analytics techniques to visualize the cost increases in the global containerized freight industry in the post-pandemic world. The visualizations provide valuable and actionable business insights for supply chain management to assess how much the containerized freight costs increase periodically and by container size.

Figure 4 shows three-year trend insights of containerized freight index in Dollars between origin of Central China (Shanghai) to the U.S. Mid-West (Chicago via LA-LB) and the U.S. West Coast (Los Angeles) by container size. The visualization uncovers valuable business insights of the continuous price trend increases of 40ft containers going to U.S. Mid-West (Chicago via LA-LB) versus 20ft containers going to the exact location.

The visualization in Figure 4 displays price leveling since March 2021 of containerized freight costs between the origin of Central China (Shanghai) going to the U.S. West Coast (Los Angeles) irrespective of the container size and between the origin of Central China (Shanghai) going to the U.S. Mid-West (Chicago via LA-LB) for the 20ft container.

The data analytics uncover a supply chain economic efficiency to encourage utilization of 20ft sized containers for the U.S. Mid-West (Chicago via LA-LB) journey instead of the 40ft size containers due to continued price pressures.

The container price will be more economically feasible to SCM and, in turn, deliver lower logistical and inventory costs. Once the containerized freight costs stabilize for the 40ft size containers between the origin of Central China (Shanghai) going to the U.S. Mid-West (Chicago via LA-LB), the SCM can switch to bigger-sized containers to deliver better economic outcomes.

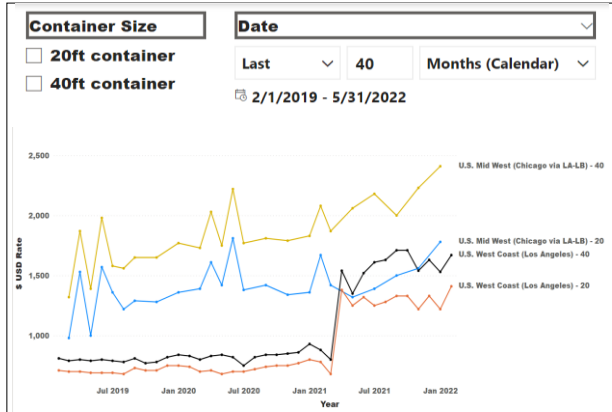


Fig. 4. Line Chart Visualization Revealing Rising Containerized Freight Costs between February 2019 – January 2022 (Dollars/Container Size/Destination)

Figure 5 offers meaningful supply chain insights of containerized freight rate index increasing by 22% or USD320 for a 20ft container and by 18% or USD374 going to U.S. Mid-West (Chicago via LA-LB) between the Year 2022 versus the Year 2021.

The containerized freight rate index did not increase significantly for the second location going to the U.S. West Coast (Los Angeles) for the same comparative period, the Year 2022 versus the Year 2021, which can be seen as a price stabilization. Despite the more considerable Year-on-Year price increase for the 20ft container versus the 40ft container going to the U.S. Mid-West (Chicago via LA-LB), SCM’s decision-making can be further enhanced by reviewing Figure 4 and Figure 5 visualizations.

The results indicate that according to the Figure 4 visualization, the 20ft container prices started to stabilize in March 2021; therefore, the Year-on-Year increase of 22% might seem less significant for SCM than initially thought. The power of visualizations proves highly valuable to SCM. The management can quickly compare and analyze complex information faster than any other traditional analysis tool, such as Microsoft Excel.

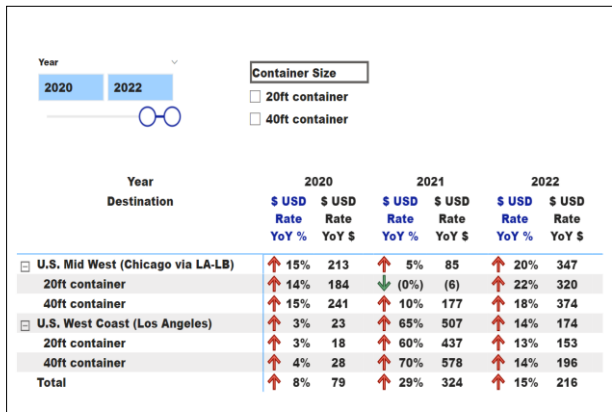


Fig. 5. Matrix Visualization Revealing Rising Annual Containerized Freight Costs between February 2019 – January 2022. (Dollars/Container Size/Destination)

The data analytics in Figure 6 uncovers that the highest three-year cumulative containerized freight rate index increased by 100% or \$802 between February 2019 and January 2022 to reach \$1,600 for a 40ft container and by 86% or \$608 to reach \$1,315 for a 20ft container going to destination U.S. West Coast (Los Angeles). The descriptive analytics technique used in

Figure 6 offers supply chain management insights into the pandemic impact on the containerized freight industry over the past three years.

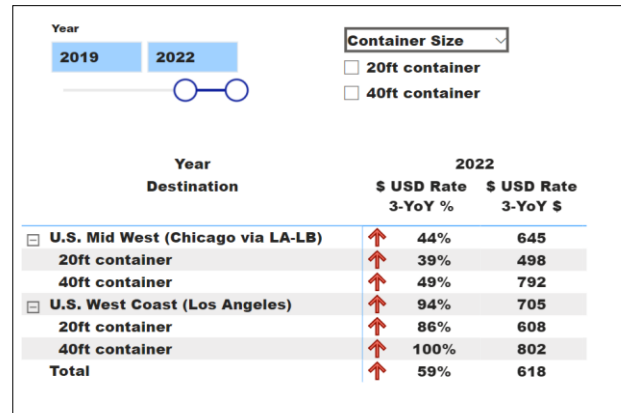


Fig. 6. Matrix Visualization Revealing Rising Three-Year Containerized Freight Costs as a percentage and absolute USD value, from February 2019 to January 2022. (Dollars/Container Size/Destination)

Ribbon chart visualization in Figure 7 offers valuable supply chain visual insights of the average cost of a container per foot over the past three years. SCM can immediately review the average cost of a container per foot by the size of a container, by year and by the destination in a quick glance. The results display that the average \$ cost of a container per foot for a 20ft container going to U.S. Mid-West (Chicago via LA-LB) is \$73 and \$51 for a 40ft container. SCM can easily track the costs by year and by destination due to the powerful, but simplistic visualizations in Power BI tool.

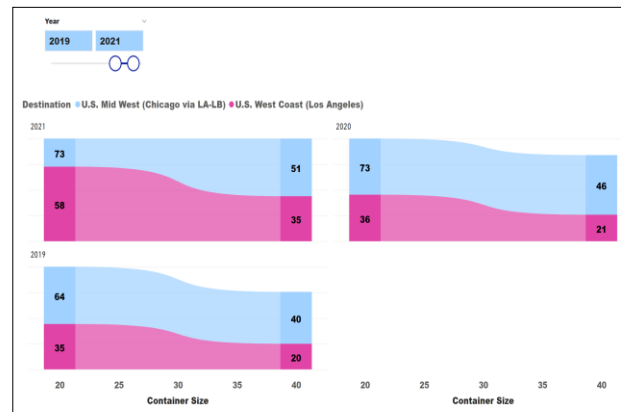


Fig. 7. Ribbon Chart Visualization Revealing Container \$ US Costs per Foot between February 2019 to January 2022 in the Post-Pandemic Period (Dollars/Container Size/Year)

## 5 Conclusions

The technique of descriptive analytics using Power BI visualizations provided valuable trends discoveries. It revealed meaningful supply chain insights of containerized freight index costs for supply chain management to act on in the post-pandemic world.

SCM can utilize data analytics and visualizations to track live containerized freight index data to enhance critical decision-making during the post-pandemic recovery. Data analytics have become the go-to strategy for success for many businesses due to the agility, interactivity, and ability to process complex data at no time. Utilizing data analytics and tools like

Power BI can help SCM avoid future inventory shortages while mitigating risks of margin erosions often influenced by transportation costs. One of the biggest drivers why businesses need to use analytics to make better decisions is the risk being posed by the sheer amount of data being gathered. The collection of unstructured data can lead to the wrong decisions unless adequately analyzed.

The results in this study demonstrate that the use of business intelligence tools such as Microsoft Power BI can be transformational in supply chain businesses due to its ability to expedite the process of data cleanup and transformation and provide insightful, interactive, decision-driven visualizations. The results drive instant decision-making by better understanding the containerized freight trends and costs on businesses. The Power BI tool in supply chain management will allow decision-makers to harness the complex data and produce actionable insights in an industry marred by shortages and delays.

*Conflict of Interest:* none declared.

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