

## Supply Chain Resilience vs. COVID-19 Disruptions

##### Dr Sheraz Alam Malik

Agenda

##### 01 Introduction & Objective

02 The Process

##### 03 Data Analysis

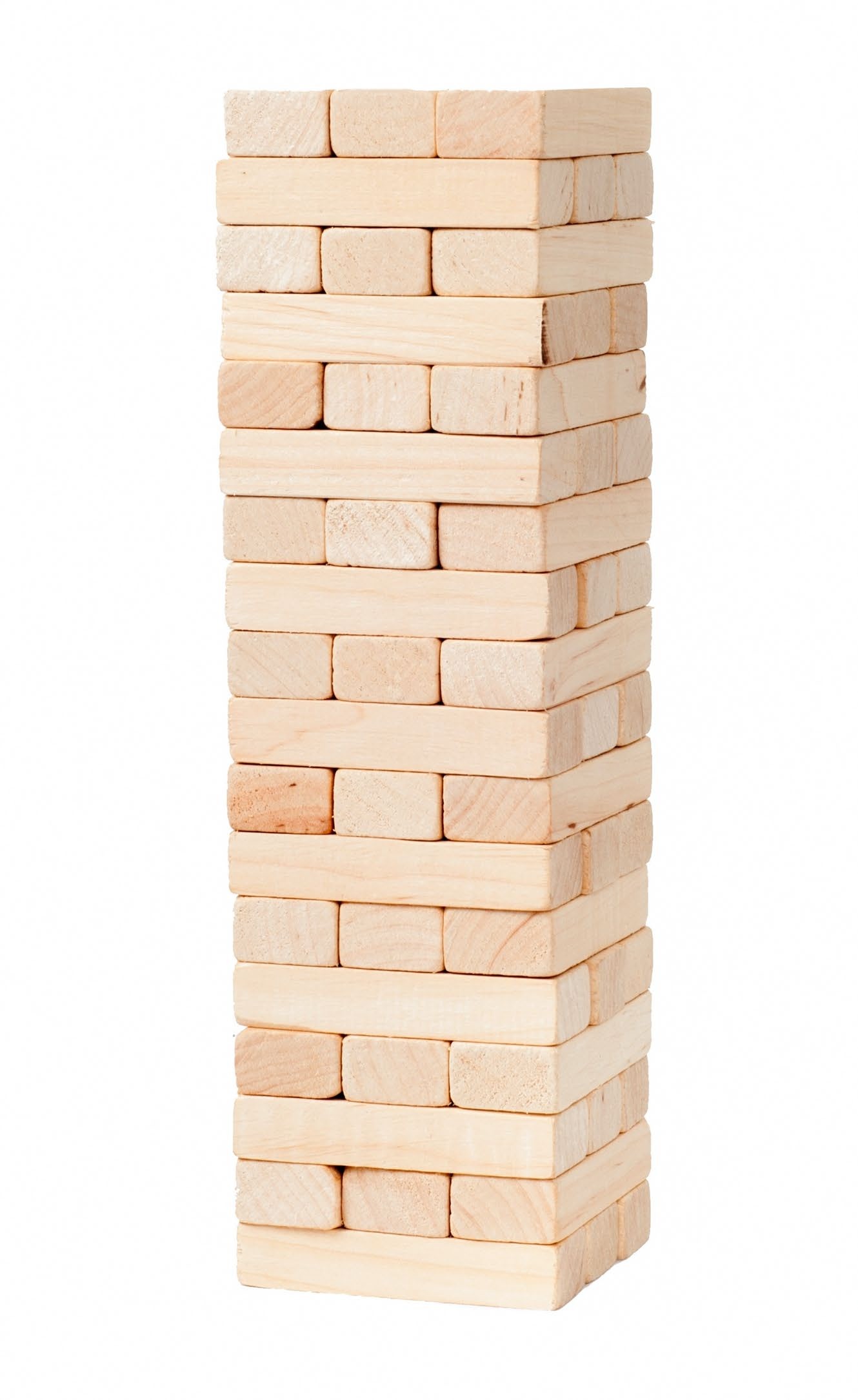
04 Conclusion & recommendations

05 Issues & challenges

# 01

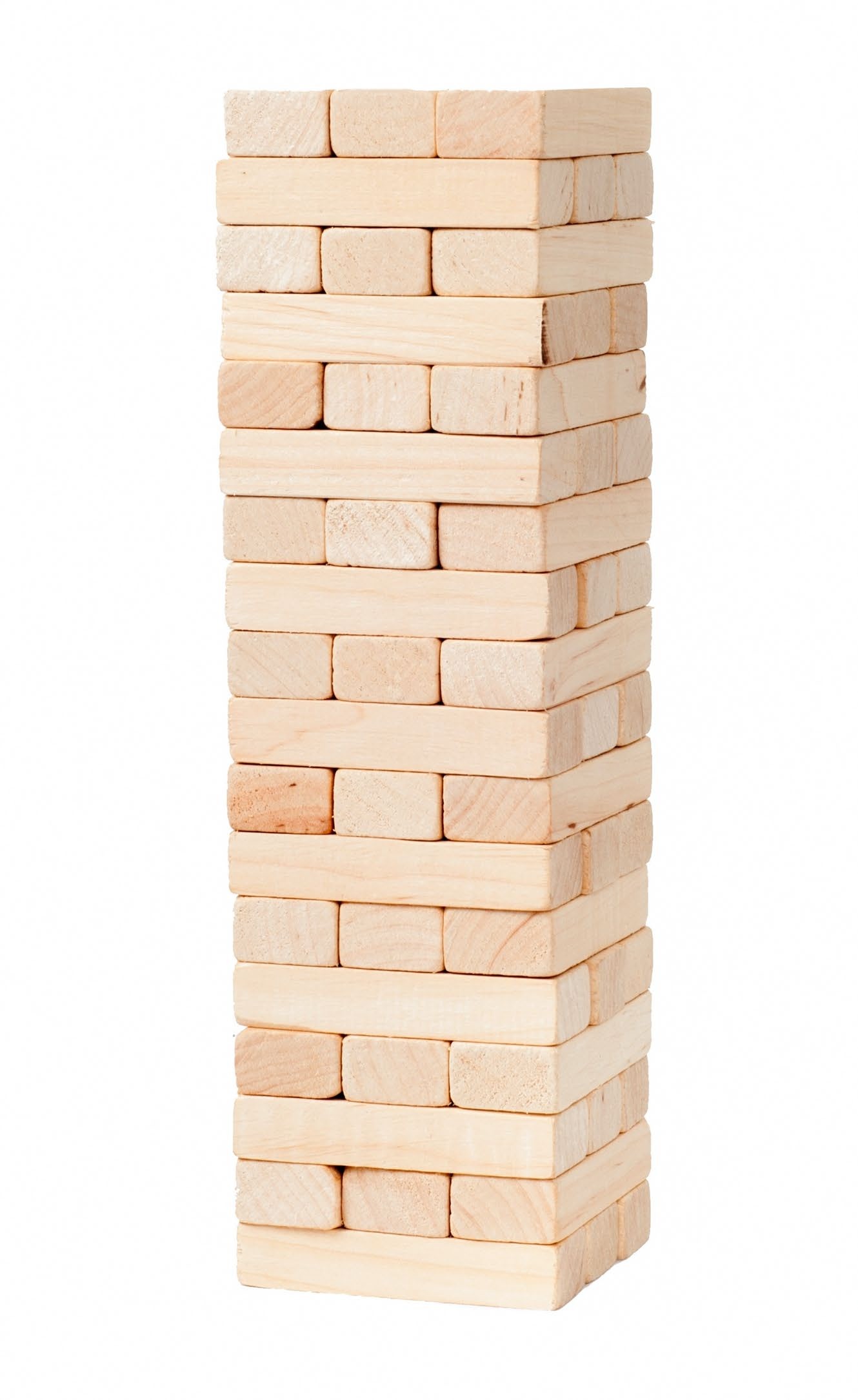
Introduction & Objective



What is Supply Chain?

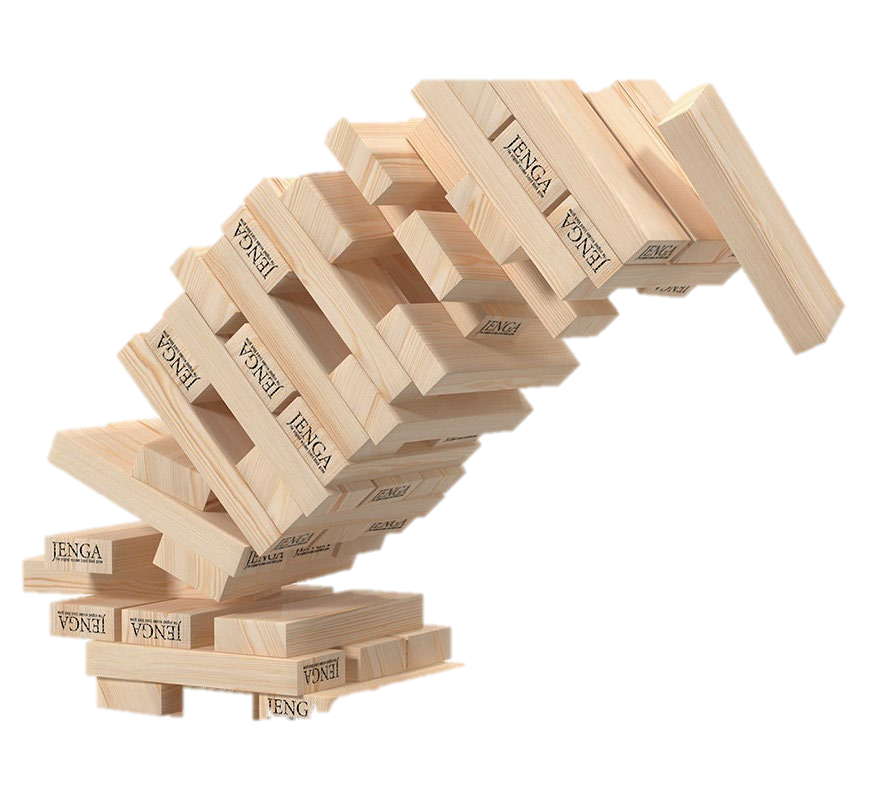
The flow of material, information, money, goods and services, from raw material suppliers through factories, offices, warehouses, to end consumers. (Lambert, et al 2000)



What is Resilience?

The ability of a supply chain system to **reduce** the probabilities of disruptions, to **reduce** the consequences of those disruptions, and to **reduce** the time to recover normal performance. (Falasca, et al 2008)

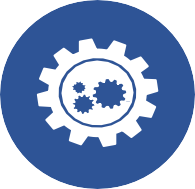




Why do supply chains have to be resilient?

The less resilient, the more vulnerable firms will be, where it is proposed that firms will be the most profitable in the long term the more resilient they are. (Pettit, et al 2010)

How to measure Supply Chain Resilience?

It is a **multidimensional** problem; it spans across multiple tiers. It is difficult to quantify. (Munoz, et al 2015).

There is **not one single model** to measure SCR



### Objective

Show how resilient are supply chains against the disruptions caused by COVID-19.



# 02

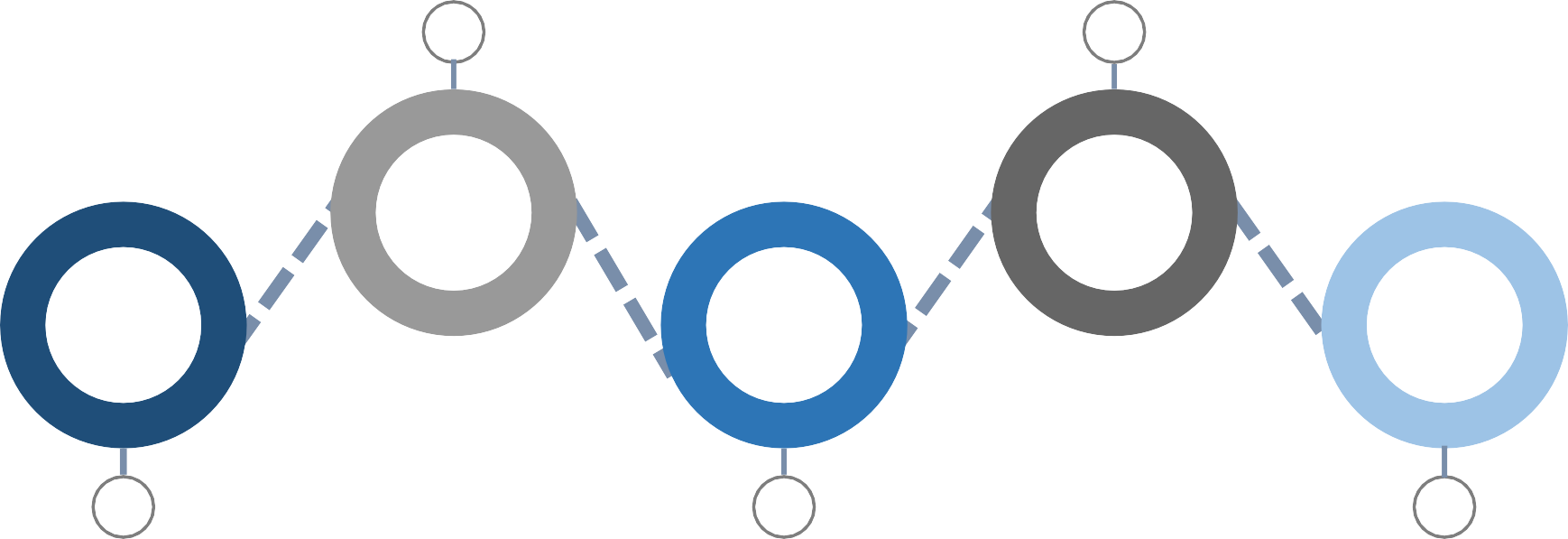
## The process



### What did we do?

**09**

Collected Data Analyzed it



02

04



|  |  |  |
| --- | --- | --- |
| 01 | 03 | 05 |
| Understood questions & built survey | Organized it | Reported it |

### Understood Questions – Survey Clarity

**10**

To ensure the clarity of some questions, we added **descriptions** to the ones we felt were ambiguous.

*Examples:*

*Please identify the major source(s) of the COVID-19 disruption.*

* Own company – you affected the supply chain of other firms
* Upstream supply chain – e.g., from suppliers to you
* Downstream supply chain **–** e.g., from you to your customers

*Please identify the major impact of the COVID-19 disruption.*

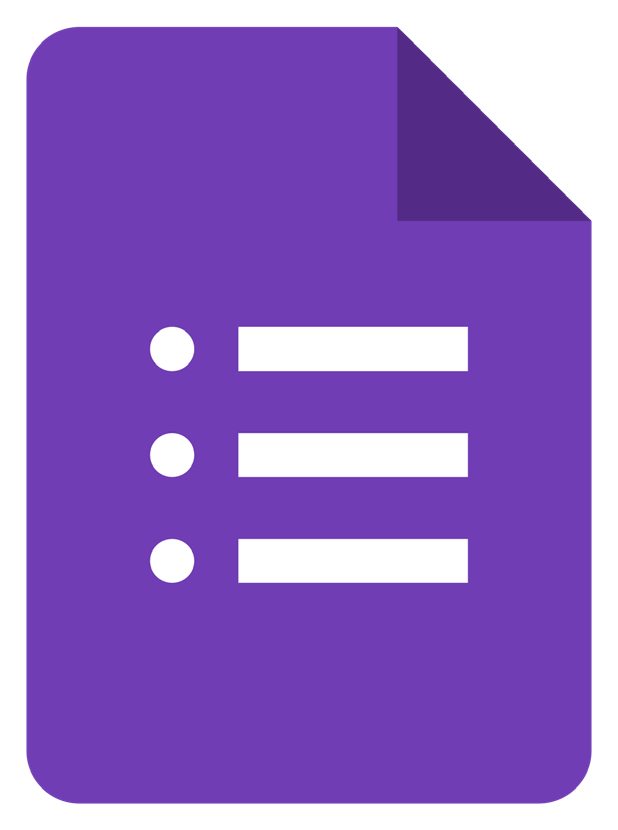
* Postponed shipping orders to customers - your decision
* Customers postponed receiving orders - their decision

Proceeded to online surveys for the remainder of the data collection process.



### Built Survey – Tool Used

**11**



Online surveys were conducted through Google Forms.



### Data Collection - Sampling & Criteria

**12**

Only those who understand what a supply chain is should take the survey The only exception was if the respondent was a C-suite level

Requests to participate were shared with potential respondents

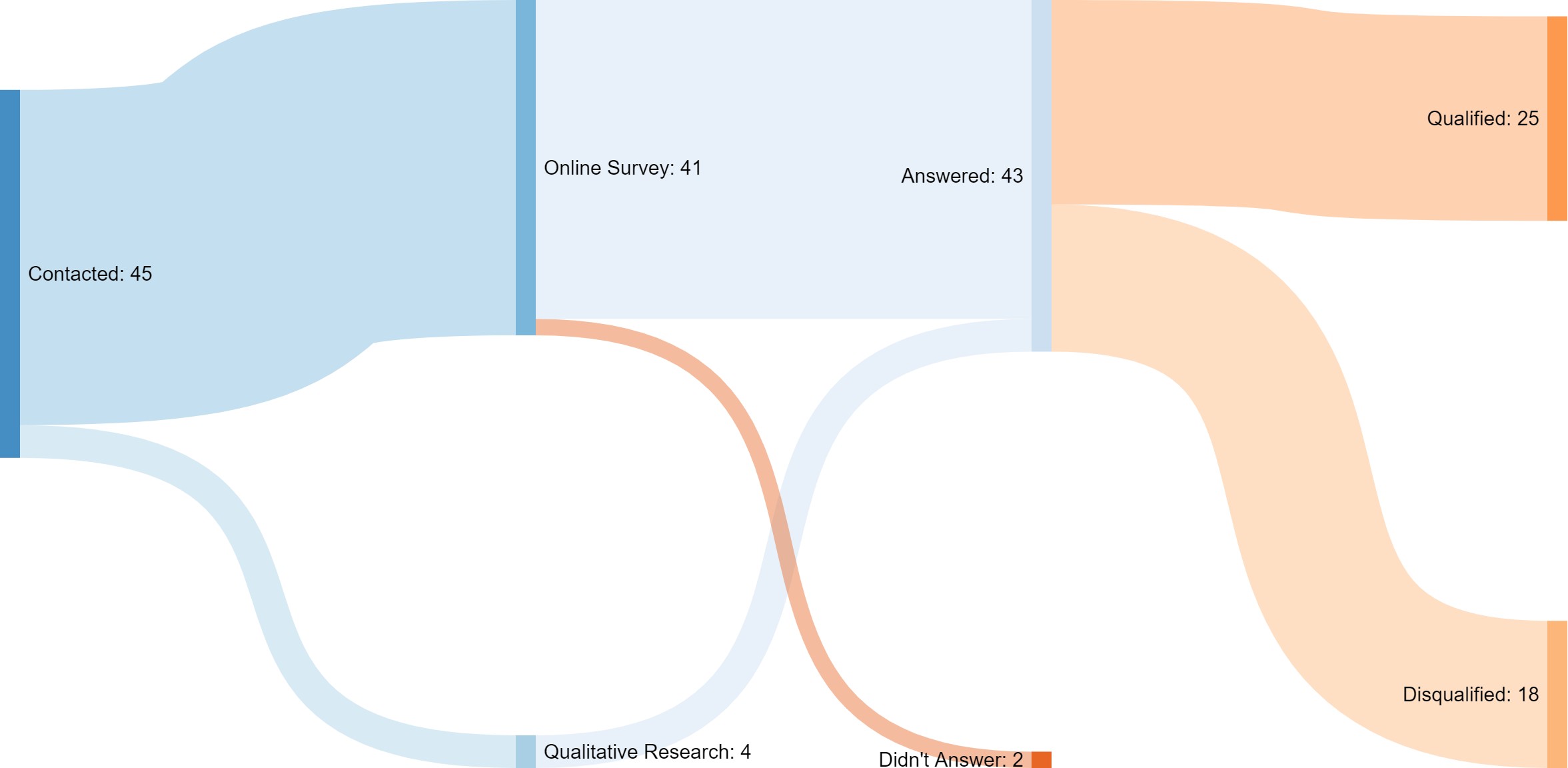
Targeted only companies working in the Kingdom – Some ended up giving the location of their global headquarters



### Data Collection – Stages

**13**

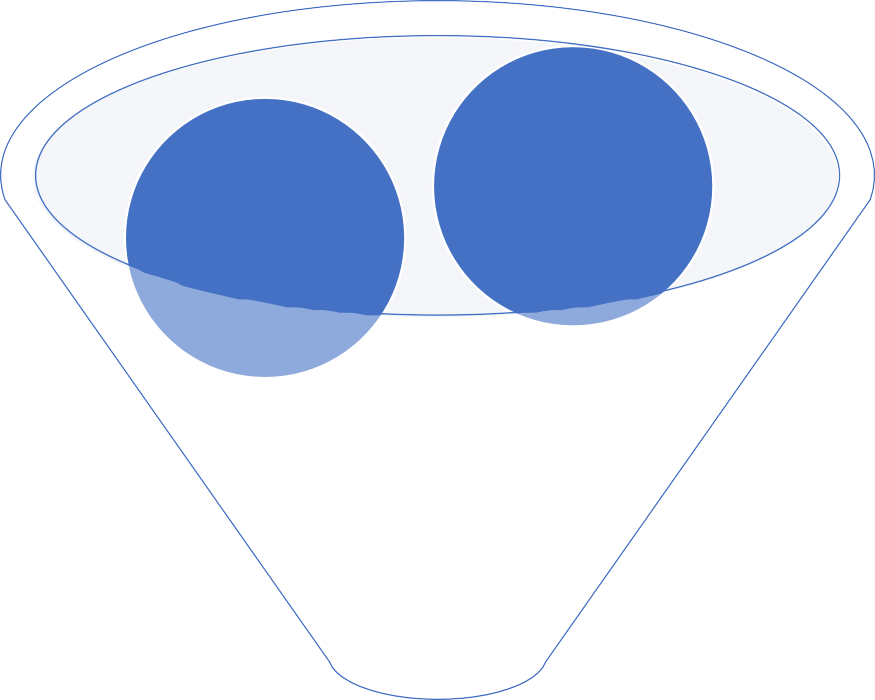
Number of respondents contacted vs. those who answered vs. those who qualified (n = 25)



### Data Organizing

**14**

Took us 5 rounds to reach a final dataset we can happily work with



Data cleaning &

format unifying

Removed

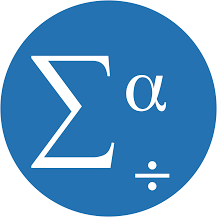
corrupt, nonmeaningful, duplicated & incomplete data

Final Dataset

### Data Analysis & Visualization

**15**

We used SPSS & Tableau and some other extensions





# 03

## Data Analysis



### So much to cover, so we will focus on THREE

**17**

areas:

#### The Sample

**1**

**Disruptions & Impact (Descriptive Analysis) Resilience (Correlation Analysis)**

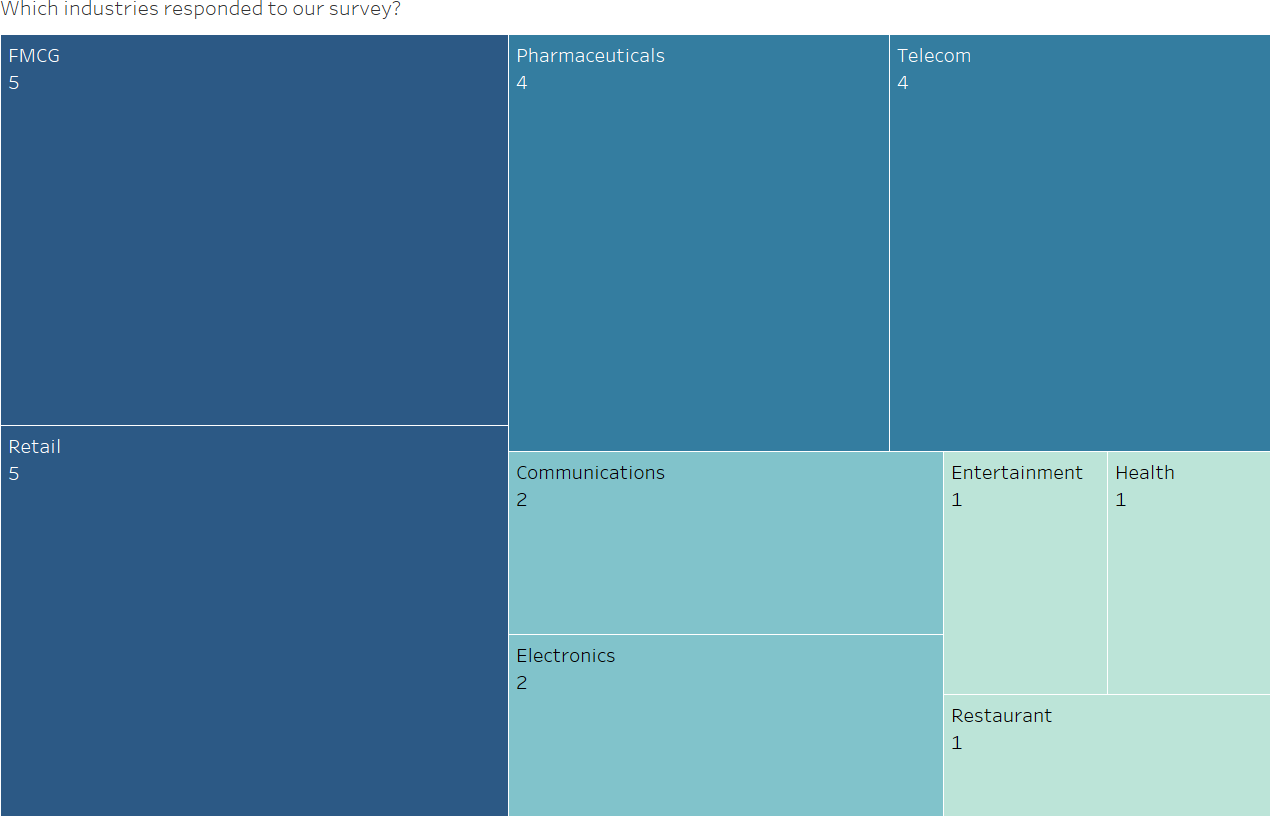
**2**

**3**

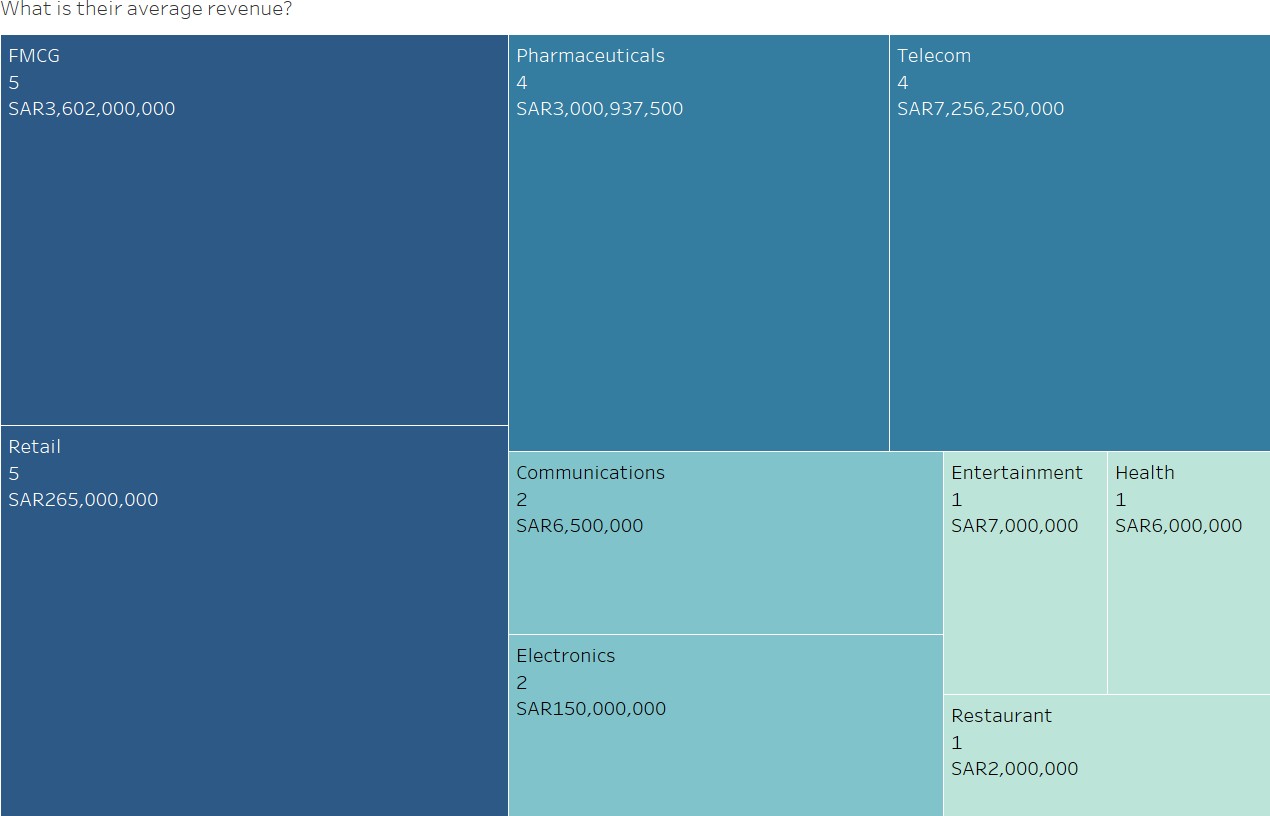


The Sample





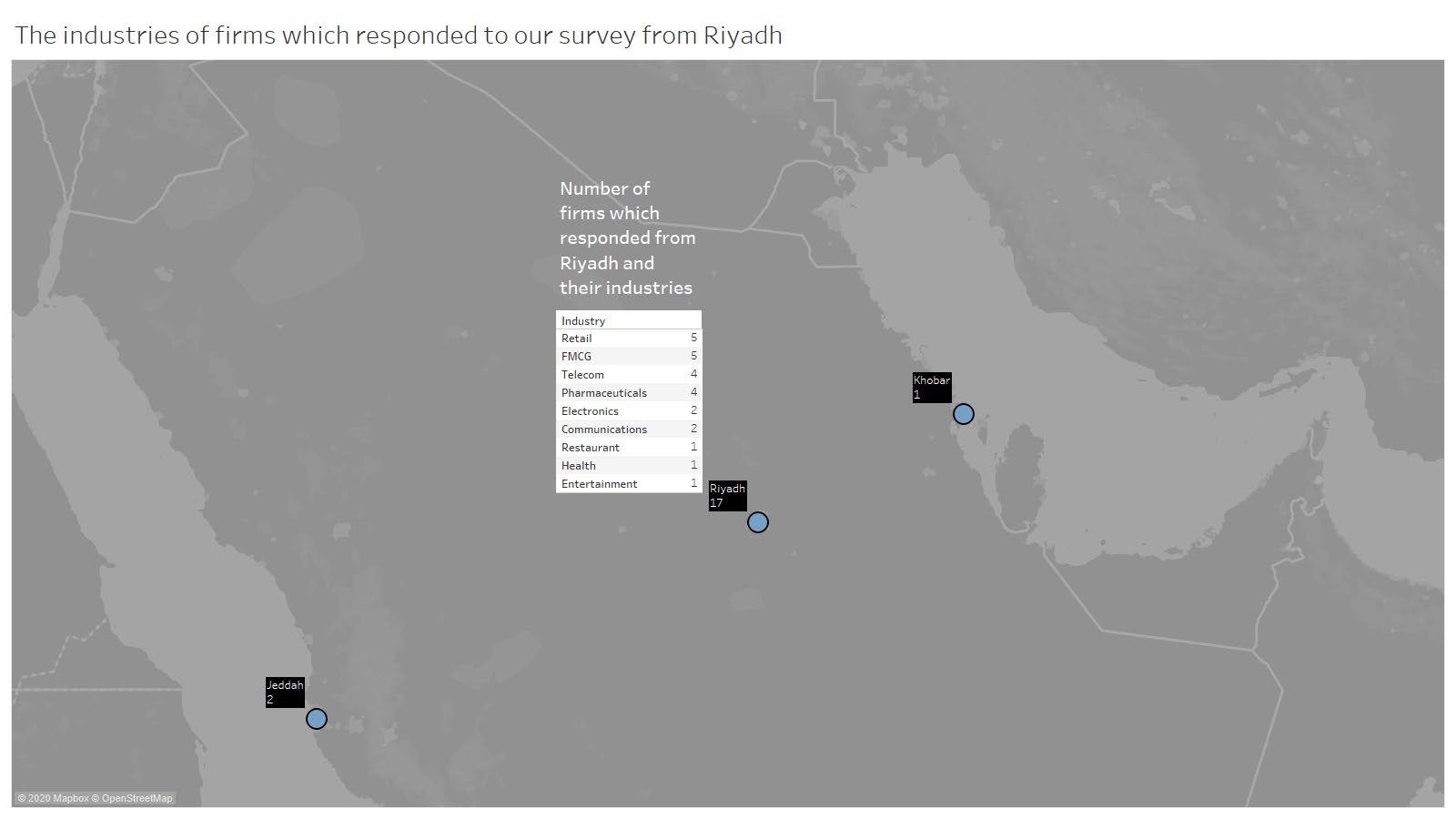
**19**



**20**



**21**

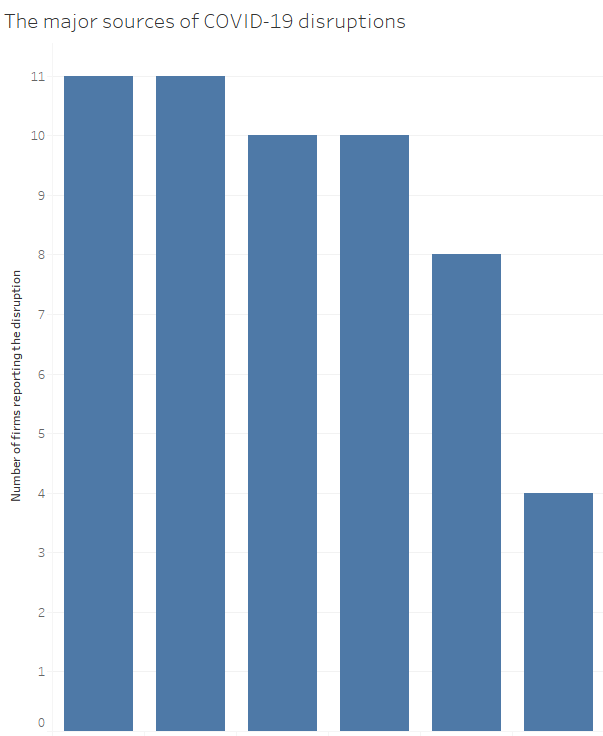


**23**

**23**

Disruptions & Impact (Descriptive Analysis)



Source of Disruption

Immediate customers

Immediate Suppliers

Upstream SC

Downstream Multiple entities in the SC

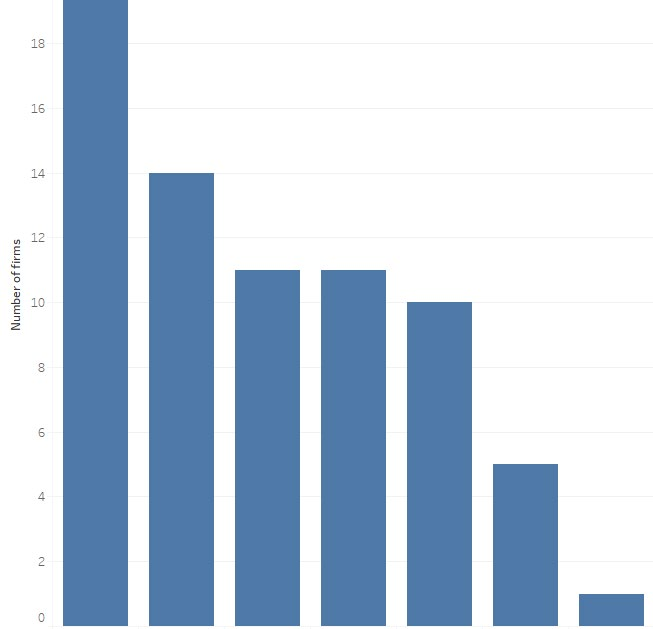
Downstre am SC

Own Company

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Source of Disruption: | | Upstream supply chain | Immediate suppliers | Own company | Immediate customers | Downstream supply chain | Multiple entities in the supply chain |
| N | Valid | 25 | 25 | 25 | 25 | 25 | 25 |
| Missing | 1 | 1 | 1 | 1 | 1 | 1 |
| Mean | | 0.44 | 0.48 | 0.16 | 0.40 | 0.32 | 0.40 |
| Median | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mode | | 0 | 0 | 0 | 0 | 0 | 0 |
| Std. Deviation | | 0.507 | 0.510 | 0.374 | 0.500 | 0.476 | 0.500 |
| Variance | | 0.257 | 0.260 | 0.140 | 0.250 | 0.227 | 0.250 |
| Skewness | | 0.257 | 0.085 | 1.975 | 0.435 | 0.822 | 0.435 |
| Std. Error of Skewness | | 0.464 | 0.464 | 0.464 | 0.464 | 0.464 | 0.464 |
| Kurtosis | | -2.110 | -2.174 | 2.061 | -1.976 | -1.447 | -1.976 |
| Std. Error of Kurtosis | | 0.902 | 0.902 | 0.902 | 0.902 | 0.902 | 0.902 |
| Range | | 1 | 1 | 1 | 1 | 1 | 1 |
| Minimum | | 0 | 0 | 0 | 0 | 0 | 0 |
| Maximum | | 1 | 1 | 1 | 1 | 1 | 1 |

Positive-skewed under **Own Company** tells us majority said they were not the source of disruption.





Disruption Impacted

Delays in Shipment from Suppliers

Unavailability of Transportation Capacity

Postponed Shipping Orders to Customers

Unavailability of Human Resources

Customers Postponing Receiving Orders

Production Interruptions in Own Company

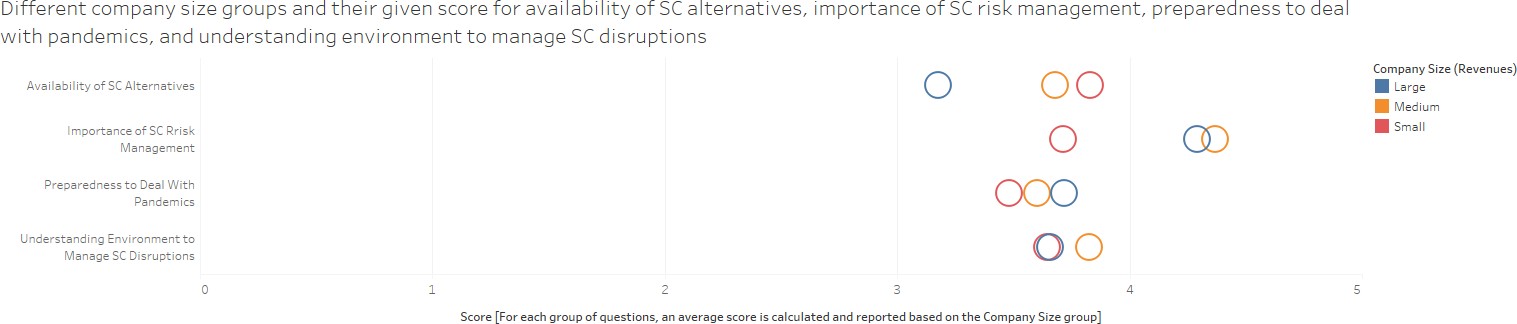
Postponing Sending Orders to Suppliers

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Disruption Impact | | Delays in shipments from suppliers | Postponing sending orders to suppliers | Production interruptions in own company | Postponed shipping orders to customers | Customers postponing receiving orders | Unavailability of transportation capacity | Unavailability of human resources |
| N | Valid | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Missing | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mean | | 0.84 | 0.04 | 0.20 | 0.48 | 0.40 | 0.56 | 0.44 |
| Median | | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| Mode | | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| Std. Deviation | | 0.374 | 0.200 | 0.408 | 0.510 | 0.500 | 0.507 | 0.507 |
| Variance | | 0.140 | 0.040 | 0.167 | 0.260 | 0.250 | 0.257 | 0.257 |
| Skewness | | -1.975 | 5.000 | 1.597 | 0.085 | 0.435 | -0.257 | 0.257 |
| Std. Error of Skewness | | 0.464 | 0.464 | 0.464 | 0.464 | 0.464 | 0.464 | 0.464 |
| Kurtosis | | 2.061 | 25.000 | 0.593 | -2.174 | -1.976 | -2.110 | -2.110 |
| Std. Error of Kurtosis | | 0.902 | 0.902 | 0.902 | 0.902 | 0.902 | 0.902 | 0.902 |
| Range | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Minimum | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maximum | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Positive-skewed under **Production interruptions in own company** tells us majority said they faced no issues at their own firms.

### Company’s Size.. Does it Matter?

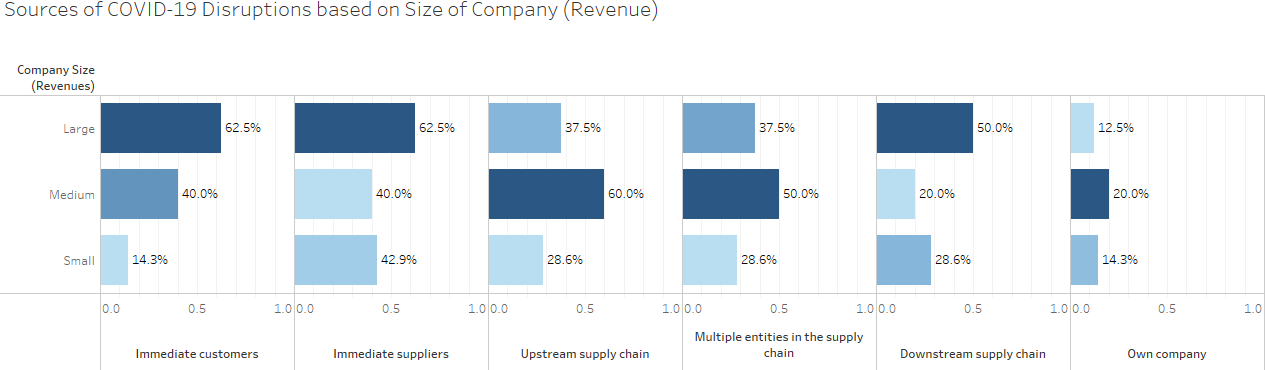
**28**



The larger the company:

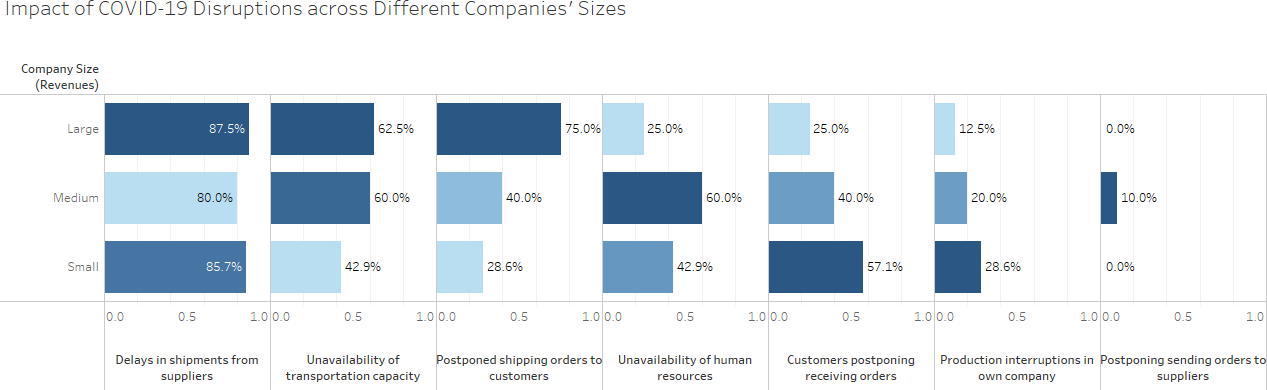
* The less available alternative to its suppl chain it has
* The more prepared it is against COVID-19 disruptions
* Medium and Large companies place higher importance on supply chai risk management Would that mean they will be disrupted less than small companies?

**29**





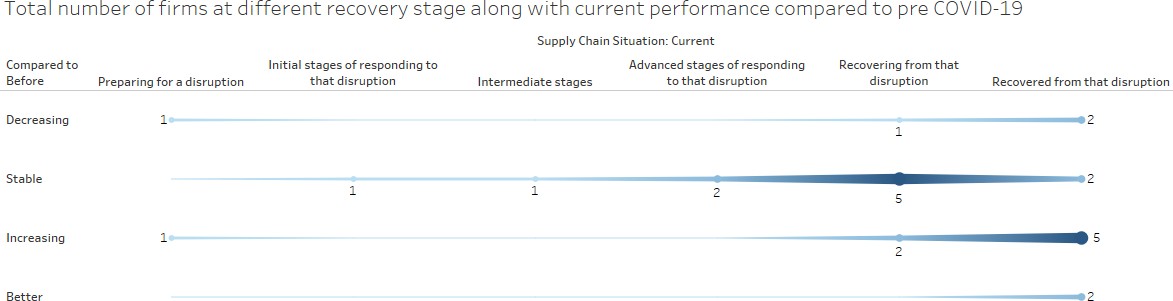
**30**





How well are they doing now ?

**31**





**Resilience**

**(Correlation Analysis)**



### What caused resilience? What helps firms

recover?

Prepatdenss to deal with pandamics



Understanding Environment to manage SC disruptions

Importance to SC Risk management

Recovery Level

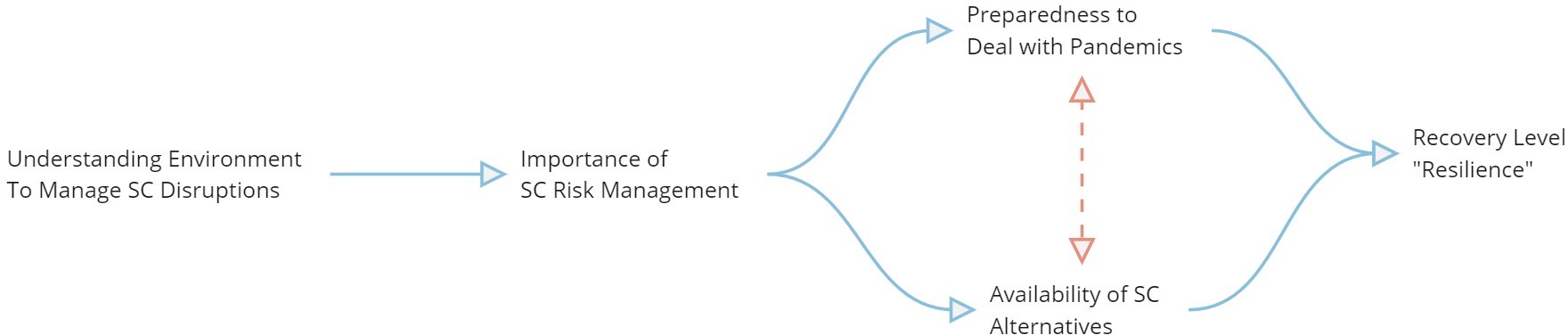
Resilience

Availability of SC alternatives





### How are they correlated?





|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| How are they correlated? | | | | | Importance: Supply chain risk management for supplier selection for raw materials and parts | Importance: Supply chain risk management for site selection |
| Spearman's rho | Understanding of environment: Perceive the | Correlation Coefficient | | | .617\*\* |  |
| Sig. (2-tailed) | | | 0.001 |  |
| N | | | 25 |  |
| events in external environment that are likely to cause disruptions |  | Bias | | -0.003 |  |
| Bootstrapc | Std. Error | | 0.119 |  |
| 95% Confidence Interval | Lower | 0.359 |  |
|  |  | Upper | 0.838 |  |
| Understanding of environment: Interpret the perceived events in the internal environment for their impact on our supply chain | Correlation Coefficient | | | .591\*\* | .567\*\* |
| Sig. (2-tailed) | | | 0.002 | 0.003 |
| N | | | 25 | 25 |
| Bootstrapc | Bias | | -.002d | -.009d |
| Std. Error | | .115d | .125d |
| 95% Confidence Interval | Lower | .343d | .293d |
| Upper | .808d | .790d |

\*\*. Correlation is significant at the 0.01 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

d. Based on 999 samples

Strong positive correlations:

1. More **importance** is given to supply chain risk management for supplier selection for raw materials and parts, the higher a firm perceives the events in external environment that are likely to cause disruptions (**understanding**)
2. More **importance** is given to supply chain risk management for site selection, the higher a firm interpret the perceived events in the internal environment for their impact on their supply chain (**understanding**)

Preparedness: We had Preparedness: We had

Preparedness: We had procedures to protect

### How are they correlated?

Correlation Coefficient

supply chain partner alternatives

.417\*

supply chain flexibility

our goods from criminal activity and contamination

.512\*\*

Spearman's rho

Importance: Supply chain risk management for supplier selection for raw materials and parts

Importance: Supply chain risk management for site selection

Importance: Supply chain risk management for transportation decisions

Sig. (2-tailed) N

Bootstrapc

Correlation Coefficient Sig. (2-tailed)

N

Bootstrapc

Correlation Coefficient Sig. (2-tailed)

N

Bootstrapc

Bias

Std. Error

95% Confidence Interval

Bias

Std. Error

95% Confidence Interval

Bias

Std. Error

95% Confidence Interval

Lower Upper

Lower Upper

Lower Upper

0.038

25

0.001

0.163

0.073

0.701

.512\*\* 0.009

25

-0.010

0.125

0.233

0.712

.448\* 0.025

25

-0.005

0.152

0.081

0.709

0.009

25

**36**

0.000

0.136

0.208

0.748

.472\* 0.017

25

-0.004

0.119

0.228

0.682

\*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Moderate positive and negative correlations between:

1. Strong positive: Firms strongly agree that they are more **prepared** and do have procedures to protect their goods from criminal activity and contamination, the higher the **importance** reported towards Supply chain risk management for supplier selection for raw materials and parts
2. Strong positive: Firms strongly agree that they are more **prepared** by having supply chain alternatives, the higher the **importance**

reported towards risk management for transportation decision

### How are they correlated?

Correlation Coefficient Sig. (2-tailed)

Preparedness: We N

Availability of Alternatives: We have alternative sourcing options for critical parts

.430\* 0.032

25

Availability of Alternatives: We have alternative markets for our finished products

Availability of Alternatives: We have alternative options to produce our goods

.408\* 0.043

25

Availability of Alternatives: We have alternative distribution channel options to deliver the goods to our customers

.478\* 0.016

25

Availability of **37**

Alternatives: We



have alternative transportation options to deliver the goods to our customers

had supply chain partner alternatives

Bootstrapc

Bias

Std. Error

95% Confidence Interval

Lower Upper

0.000

0.160

0.085

0.723

0.001

0.177

0.029

0.711

-0.003

0.159

0.131

0.743

Correlation Coefficient

.630\*\*

.438\*

Spearman's rho

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Sig. (2-tailed) |  |  | 0.001 | 0.029 |
| Preparedness: Our | N |  |  | 25 | 25 |
| employees had the  skills to deal with |  | Bias |  | 0.002 | 0.003 |
| the disruption | Bootstrapc | Std. Error |  | 0.184 | 0.197 |
|  |  | 95% Confidence | Lower | 0.225 | -0.012 |
|  |  | Interval | Upper | 0.908 | 0.764 |
|  | Correlation Coefficient | | | .458\* |  |
|  | Sig. (2-tailed) |  |  | 0.021 | |
| Preparedness: We | N |  |  | 25 | |
| had procedures |  | Bias |  | -0.002 | |
| and plans in place | Bootstrapc | Std. Error |  | 0.187 | |
|  |  | 95% Confidence | Lower | 0.066 | |
|  |  | Interval | Upper | 0.784 | |
| Preparedness: We | Correlation Coefficient Sig. (2-tailed)  N | | | .442\* 0.027  25 | |

had supply chain

Bias

0.006

|  |  |  |  |
| --- | --- | --- | --- |
| visibility  Bootstrapc | Std. Error |  | 0.210 |
|  | 95% Confidence | Lower | 0.022 |
|  | Interval | Upper | 0.815 |

\*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

### How are they correlated?

**38**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | | Preparedness: Supply chain partners were willing to collaborate with us | Availability of Alternatives: We have alternative markets for our finished products |
|  |  | Correlation Coefficient | | | .504\* | -.452\* |
|  |  | Sig. (2-tailed) | | | 0.012 | 0.027 |
|  |  | N | | | 24 | 24 |
| Spearman's rho | Supply Chain Situation: Current | Bootstrapc | Bias | | -0.013 | 0.007 |
|  |  | Std. Error | | 0.129 | 0.166 |
|  |  | 95% Confidence Interval | Lower | 0.185 | -0.724 |
|  |  | Upper | 0.702 | -0.086 |

\*. Correlation is significant at the 0.05 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Strong & Moderate positive correlations between:

1. Strong: The more **preparedness** firms shown in terms of collaborations with their supply chain partners, the better the **current**

supply chain **situation**

1. Moderate: The less markets for finish products **available** to a firm, the better the **current** supply chain **situation** is

# 04

## Conclusion & Recommendations



### Reminder

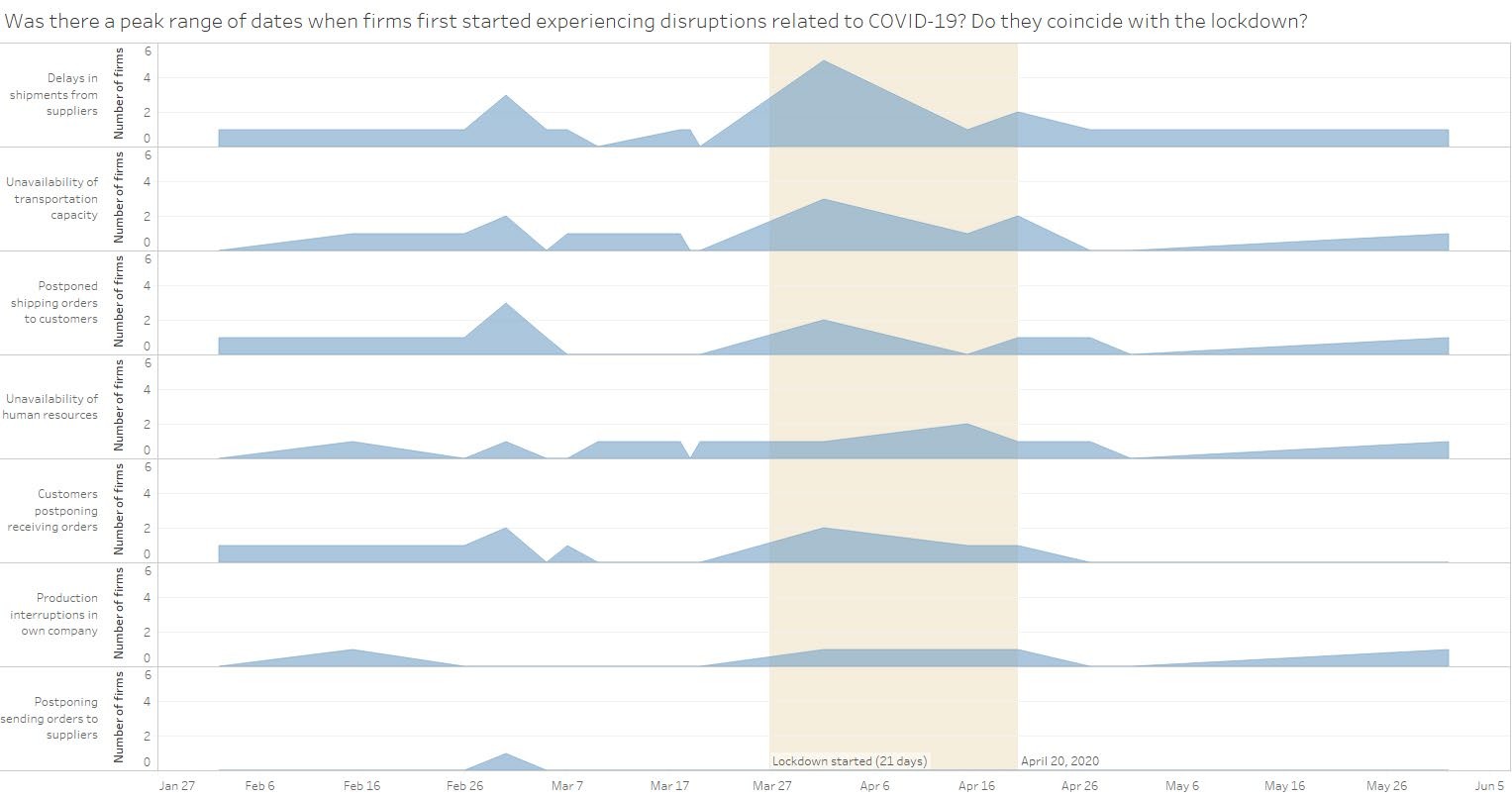
**40**

Resilience: The ability of a supply chain system to:

* + REDUCE the **probabilities** of **disruptions**
  + REDUCE the **consequences** of those disruptions
  + and to REDUCE the **time** to **recover** normal performance.

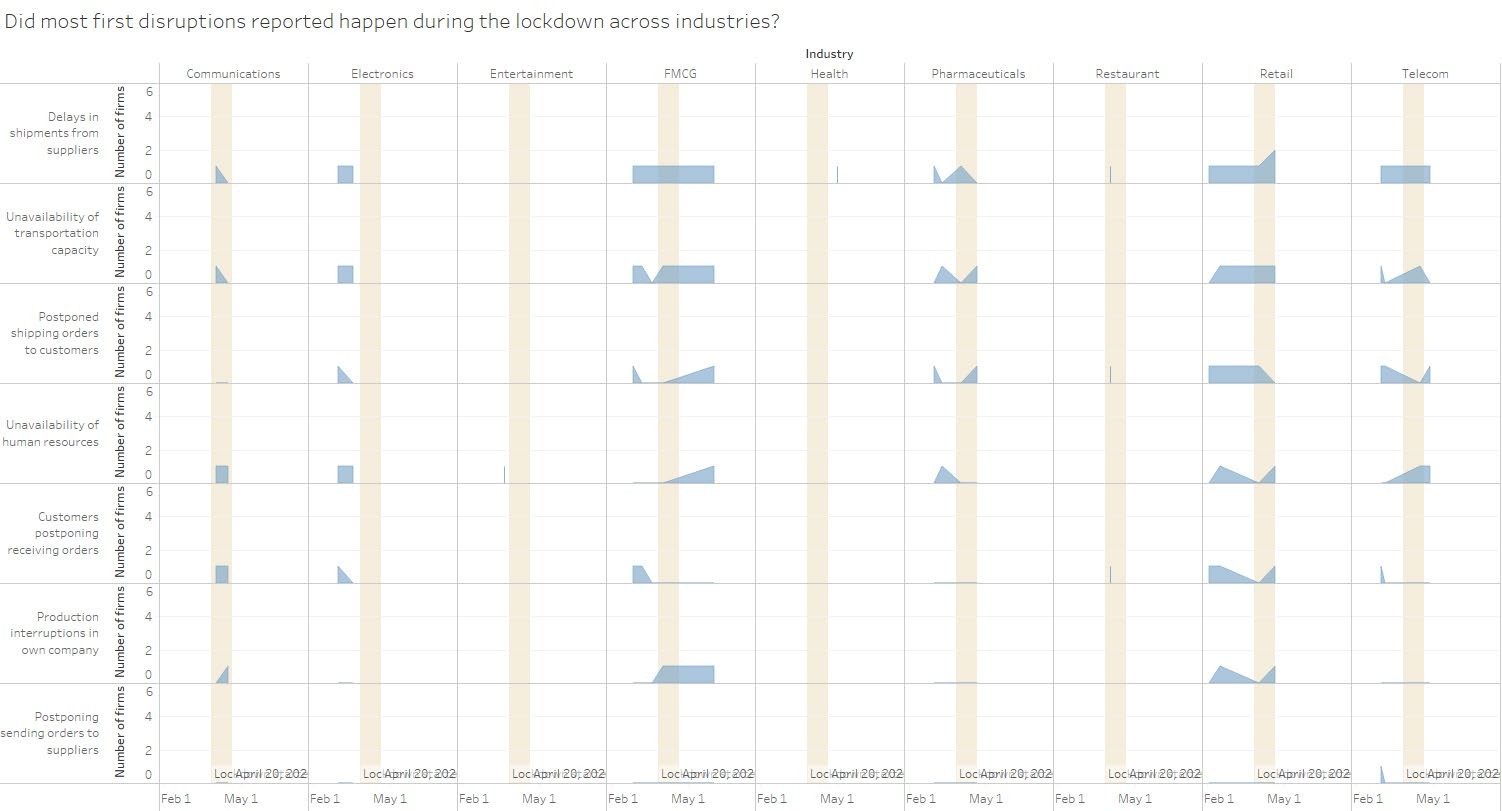
Falasca, et al (2008, May).





**42**

If each disruption was reported at a specific date, we wouldn’t see the first spike (pre-lockdown)

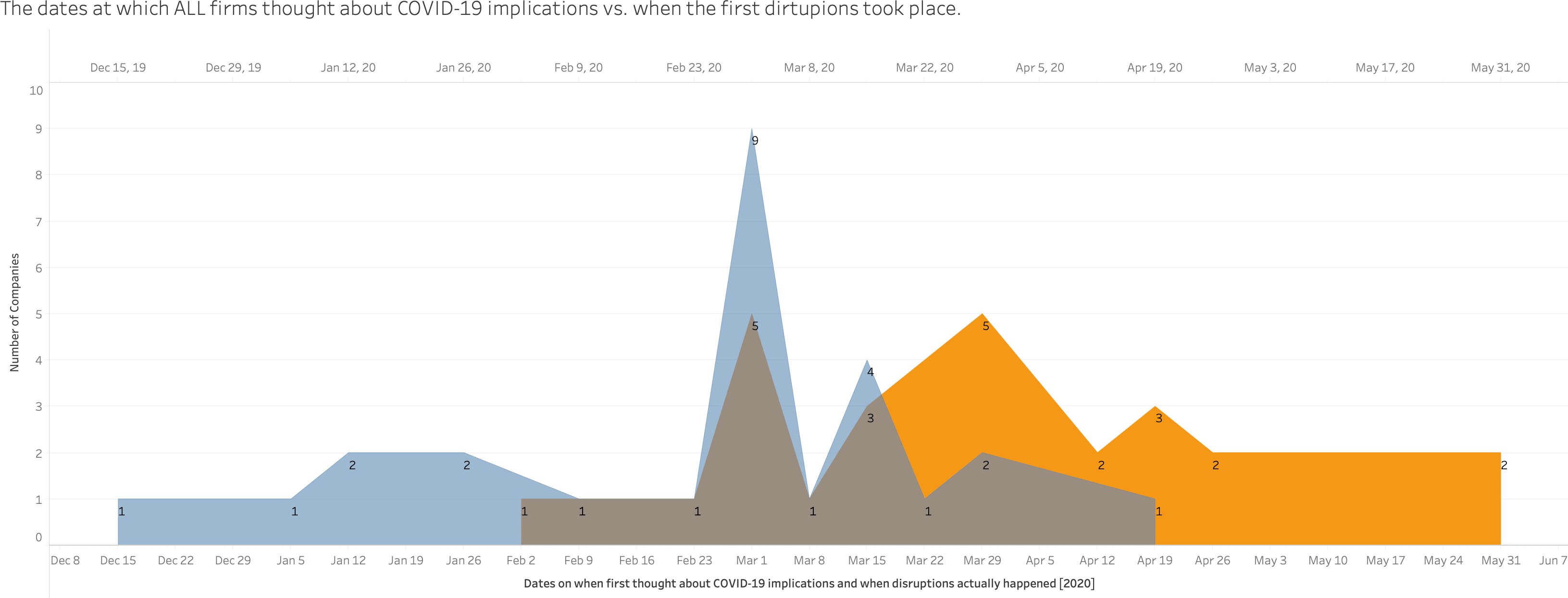


**42**

Six weeks of overlapping phases – **Learning Window** (first when thought of implications vs. when disruptions first happened) – A **Learning Window** would help in **REDUCING** the **probabilities** of **disruptions**

**43**

Dates at which firms were thinking of COVID-19 implications



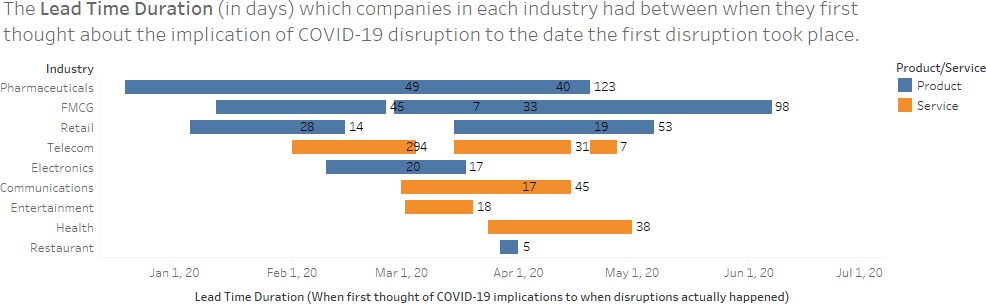
Dates at which firms witnessed COVID-19 disruptions

Learning Window

Companies dealing with products had longer lead time (**Action Window**) between when they first thought about implications to the day actual disruptions took place.

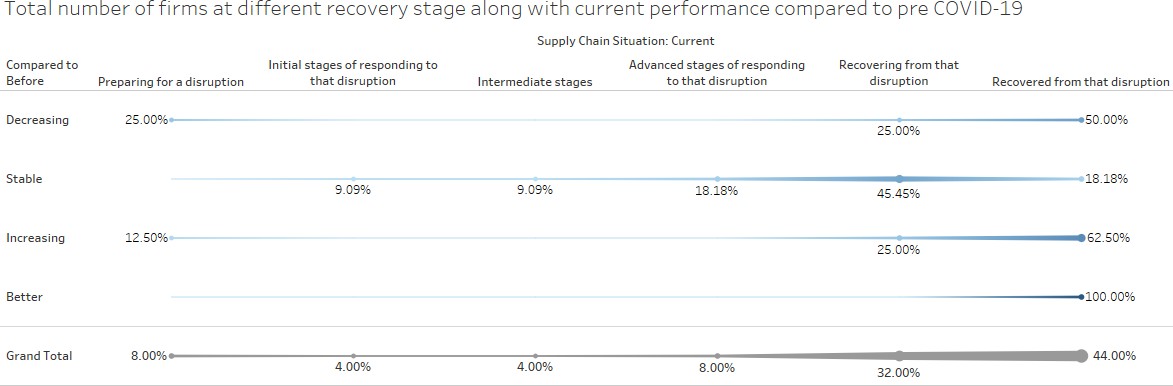
**44**

An **Action Window** would help in **REDUCING** the **consequences** of those disruptions. (for both products and services providers); the longer, the less impact.



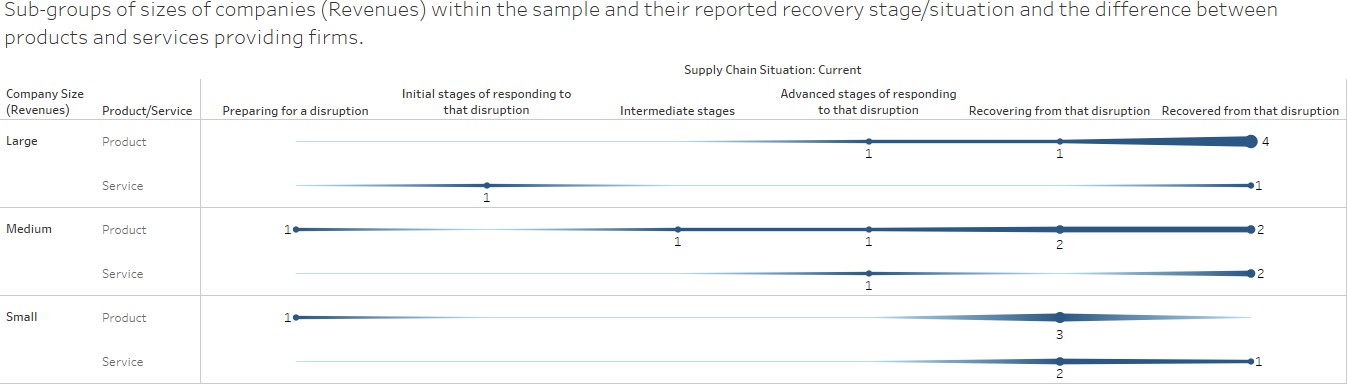
*Calculated field = Lead Time Duration (in days)*

*Equation: First when thought about COVID-19 implications – Date when first disruption took place*



* 76% of sample are either **recovering** or have **recovered** from COVID-19 disruptions
* 80.7% of sample are either in a **stable** or **increasing** performance/situation compared to pre COVID-19 disruptions





###### Product vs. Service:

* + 70.6% of firms selling **products** are either **recovering** or have **recovered** from the disruption, of these 75% are either **medium** or **large** companies
  + 75% of firms selling **services** are either **recovering** or have **recovered** from the disruption, of these 50% are either **medium** or **large** companies

###### Graphical user interface, text, application Description automatically generatedSize:

* + 62.5% of **large** companies (products & services) have fully recovered
  + 33.33%% of **medium** companies (P&S) have fully recovered
  + 14.3% of **small** companies (P&S) have fully recovered

### What could next studies focus on?

Measure resilience against the product/service production complexity

Level of firms’ liquidity during the disruptions and if this has any correla**J**t**A**io**N**n**UA**w**R**ith**2** r**1**e**9**silience

Investigate the digital sales maturity level of firms during the time of disruptions to check if firms who are selling online had less disruptions than those which do not

Could add another question, which would allow us to further analyze; **if we add day of recovery for each reported disruption**, then we could show which industry/firm had a more SC resilience.

**48**

# 05

## Issues & Challenges



### Issues

Some respondents decided **to not share** their answers when giving the name of their firm was mandatory (even C-suite level)



Some – who are working with international firms – answered questions pertaining to revenues and number of employees considering the overall firm, **not the local branch**  caused outliers, some were fixed via callbacks, others were assumed, others were unchanged



Questions were **too long**, neither SPSS nor Tableau would show the full text, ended up shortening them but keeping the meaning; they were difficult to handle even on excel



It was easier to catch anomalies for earlier respondents, since the distribution of the survey was limited, fixing these was easy, the more the survey got circulated, the more difficult it was to know who is who

### Challenges

We wish we did not start early; more understanding of SPSS would have enabled us to use better surveying techniques, example: A Likert scale could have been numerical instead of coding in SPSS

Some of the questions are not timely, which meant **less accurate** results

Sample size is **small**, we wished we focused on 2 industries to have specific and direct findings more worthy of reporting



References

**51**

* + - Lambert, Douglas M., and Martha C. Cooper. "Issues in supply chain management." *Industrial marketing management* 29, no. 1 (2000)
    - Munoz, A., & Dunbar, M. (2015). On the quantification of operational supply chain resilience. *International journal of production research*
    - Falasca, M., Zobel, C. W., & Cook, D. (2008, May). A decision support framework to assess supply chain resilience. In *Proceedings of the 5th International ISCRAM Conference*
    - Pettit, Timothy J., Joseph Fiksel, and Keely L. Croxton. "Ensuring supply chain resilience: development of a conceptual framework." *Journal of business logistics* 31, no. 1 (2010)



## Shukrn.

