

Understanding the State of Supply Chain Sustainability

by

Avanika Gupta

B.S. in Mathematics and Economics, University of California, San Diego, 2017

and

Taryn Wenske

B.B.A. in Supply Chain Management and Business Honors, Texas A&M University, 2018

SUBMITTED TO THE PROGRAM IN SUPPLY CHAIN MANAGEMENT
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF APPLIED SCIENCE IN SUPPLY CHAIN MANAGEMENT
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 2022

© 2022 Avanika Gupta and Taryn Wenske. All rights reserved.

The authors hereby grant to MIT permission to reproduce and to distribute publicly paper and electronic copies of this capstone document in whole or in part in any medium now known or hereafter created.

Signature of Author: _____

Department of Supply Chain Management

May 6, 2022

Signature of Author: _____

Department of Supply Chain Management

May 6, 2022

Certified by: _____

Dr. David Correll
Research Scientist and Lecturer at Massachusetts Institute of Technology
Capstone Advisor

Accepted by: _____

Prof. Yossi Sheffi
Director, Center for Transportation and Logistics
Elisha Gray II Professor of Engineering Systems
Professor, Civil and Environmental Engineering

Understanding the State of Supply Chain Sustainability

by

Avanika Gupta

and

Taryn Wenske

Submitted to the Program in Supply Chain Management
on May 6, 2022, in Partial Fulfillment of the
Requirements for the Degree of Master of Applied Science in Supply Chain Management

ABSTRACT

The emphasis on sustainability within supply chains across industries has increased in recent years. Today, companies across the globe report on sustainability efforts and progress each year and set goals to reach ambitious environmental and social sustainability targets. This increased focus has prompted questions regarding how sustainability practices are interpreted and understood. How do different demographic groups (i.e., gender, language, location, age, and industry) interpret the current state of supply chain sustainability? Have the long-term implications of COVID-19 affected companies' commitments to supply chain sustainability? Our analysis used response data from the 3rd Annual State of Supply Chain Management Survey and context gathered through supply chain executive interviews to answer the two main research questions. After slicing the survey response data into demographic categories – gender, age range, region, survey language translation, and industry – we performed non-parametric Mann-Whitney-U and Kruskal-Wallis ANOVA tests to see if the different groups interpret sustainability commitments significantly differently. When testing within single demographics, results showed significant differences in responses by demographics. This seemed to explain some of the difference in how people interpreted supply chain sustainability; however, when isolating groups further, this became less apparent. Upon isolating the gender, age range, and location demographics by major industries, fewer responses showed significant differences. From this, we can conclude that comparisons of sustainability guidelines and practices should be industry-specific, rather than specific to other demographics such as gender, age, or location. Our capstone results could provide the basis for future research to understand the variations in how different groups of people interpret supply chain sustainability within the same company, industry, or outside of an organizational setting entirely.

Capstone Advisor: Dr. David Correll

Title: Research Scientist and Lecturer at Massachusetts Institute of Technology

ACKNOWLEDGEMENTS

We would like to thank our advisor Dr. David Correll for being an extremely patient, supportive, and enthusiastic supporter. His open and encouraging conversations and insights were very helpful throughout our research. We would also like to thank Kellen Betts and the MIT Center for Transportation and Logistics team for being great resources during our research. We would also like to thank Toby Gooley, our writing coach for her great feedback through the semester. We also wish to thank the CSCMP and their network for helping facilitate interview sessions with supply chain executives. Their input was greatly appreciated and valued for our research. Lastly, we are immensely thankful for our friends, families, and fellow students in the MIT Supply Chain Management Master's program, who have all been incredibly supportive of the time and effort we have put into this program and our capstone.

Avanika Gupta and Taryn Wenske

TABLE OF CONTENTS

LIST OF FIGURES.....	6
LIST OF TABLES.....	7
1. INTRODUCTION.....	8
1.1 Motivation.....	8
1.2 Research Questions.....	10
2. LITERATURE REVIEW.....	11
2.1 Introduction.....	11
2.2 Past State of Supply Chain Sustainability Findings.....	12
2.3 Origins of Modern Sustainability.....	13
2.4 Social Sustainability.....	14
2.5 COVID-19 Impacts on Sustainability.....	16
2.6 Conclusion.....	18
3. METHODOLOGY.....	19
3.1 Survey Data.....	20
3.1.1 Data Cleansing and Preparation.....	21
3.1.2 Social and Environmental Question Consolidation.....	22
3.1.3 Internal and External Pressure Question Consolidation.....	23
3.1.4 Demographic Data Grouping.....	24
3.2 Survey Response Analysis.....	25
3.2.1 Mann-Whitney U Test.....	26
3.2.2 Kruskal-Wallis Test.....	27
3.2.3 Testing Across Multiple Demographics.....	28
3.3 Executive Interviews.....	29
4. RESULTS.....	30
4.1 Respondent Summary.....	31
4.1.1 Gender.....	31
4.1.2 Language Translation.....	32
4.1.3 Location.....	33
4.1.4 Age Range.....	34

4.1.5 Industry.....	35
4.1.6 Executive Interviews.....	36
4.2 Test Results by Demographic.....	37
4.2.1 Gender.....	37
4.2.2 Language Translation.....	39
4.2.3 Location.....	40
4.2.4 Age Range.....	41
4.2.5 Industry.....	41
4.2.6 Testing Across Multiple Demographics.....	42
5. QUALITATIVE FINDINGS FROM EXECUTIVE INTERVIEWS.....	42
6. DISCUSSION.....	47
6.1 Current State of Supply Chain Sustainability.....	48
6.2 Variation in Responses by Demographic.....	49
6.3 Long-Term Implications of COVID-19.....	50
6.4 Limitations.....	51
6.4.1 Respondent Sample.....	51
6.4.2 Optional Demographic Questions.....	51
6.4.3 Survey Limitations.....	52
6.5 Recommendations.....	52
7. CONCLUSION.....	54
References.....	56
Appendix A - Demographic Distribution of Respondents.....	58
Appendix B – Demographic Response Test Results Isolated by Industry.....	60

LIST OF FIGURES

Figure 1: Methodology Approach 19

Figure 2: Number of Responses by Gender 31

Figure 3: Breakdown of Survey Responses by Language..... 32

Figure 4: Number of Responses by Location 33

Figure 5: Number of Responses by Age Range 34

Figure 6: Number of Responses by Industry..... 35

Figure 7: Significance - SCS Environmental & Social Goals - Response Difference by Gender..... 38

Figure 8: Significance - SCS Environmental & Social Investments- Response Difference by Gender 38

Figure 9: Significance - COVID-19 Impact on Environmental & Social SCS Commitments - Response Difference by Gender 38

Figure 10: Significance - COVID-19 Impact on Environmental & Social SCS Commitments - Response Difference by Language Translation 40

LIST OF TABLES

Table 1: Survey Questions Grouped by Social and Environmental Sustainability	22
Table 2: Survey Questions Grouped by Internal and External Sustainability Pressures	23
Table 3: Groupings Within Each Demographic Data Category.....	24
Table 4: Demographic Grouping Tested Using Mann-Whitney U	26
Table 5: Demographic Grouping tested using Kruskal-Wallis.....	27
Table 6: Executive Interview Questions for 2021 State of Supply Chain Sustainability Report ...	29
Table 7: Significant Differences in Responses by Gender.....	37
Table 8: Significant Differences in Responses by Language Translation	39
Table 9: Significant Differences in Responses by Location	40
Table 10: Significant Differences in Responses by Age Range.....	41
Table 11: Significant Differences in Responses by Industry	41

1. INTRODUCTION

As the effects of global disruptions such as the COVID-19 pandemic and the increase in e-commerce buying have drastically impacted the sourcing, manufacturing, and distribution of goods and products, “supply chain” has become a household phrase. Other major events in 2021, such as the UN Climate Change Conference, unprecedented extreme weather events, and the United States restoring relationships with the World Health Organization and the Paris Climate Agreement, have put environmental and social awareness at the forefront of people’s minds. These events along with the increased public perception of supply chain management has in turn increased awareness of supply chain sustainability (SCS). As awareness has increased, the Massachusetts Institute of Technology Center for Transportation & Logistics (MIT CTL) and the Council of Supply Chain Management Professionals (CSCMP) recognized that there was an information gap on the understanding of the current state of supply chain sustainability and its impact across industries. To provide the basis of annual research to document and understand the evolution of supply chain sustainability, the two organizations collaborated to develop and publish the annual State of Supply Chain Sustainability report. We know that people have different understanding and interpretations of supply chain sustainability, and through this capstone we look to gain insight into how demographics play a role in how people understand the state of supply chain sustainability.

1.1 Motivation

First published in 2020, the Annual State of Supply Chain Sustainability report by the Massachusetts Institute of Technology Center for Transportation and Logistics in partnership

with the Council of Supply Chain Management Professionals was designed to examine how sustainability practices were prioritized and executed in global supply chains. Between a global pandemic, major social justice movements, and an influx of climate crises, 2020 was a year marked by major events. Supply chains across all industries and geographies were faced with the task of reacting to effects of these major disruptions such as shipments delays and labor shortages. The 2020 survey results and interviews with supply chain professionals across industries revealed that even during times of uncertainty, supply chain sustainability remains a top priority for companies (MIT Center for Transportation and Logistics and Council of Supply Chain Management Professionals, 2021). In the following year, the second annual State of Supply Chain Sustainability report found that, despite continuing supply chain disruptions, commitment to sustainability did not waver (MIT CTL and CSCMP, 2021). As global supply chains recover and adapt to a post-COVID-19 world, companies are facing decisions regarding whether practices, such as working remotely and increased focus on employee well-being, developed in 2020 and 2021 will be temporary or continue into the future.

The Annual State of Supply Chain Sustainability report can not only provide a view of supply chain professionals' perspective on their organizations' commitments to sustainability but can also offer actionable insights for companies based on their priorities. Using the 2022 Annual State of Supply Chain Sustainability survey responses, we will analyze how different groups of people interpret sustainability commitment and investments across global supply chains.

1.2 Research Questions

The study will examine two key questions across different categories of data:

1. How do different demographic groups (i.e., gender, language, location, age, and industry) interpret the current state of supply chain sustainability?
2. Have the long-term implications of COVID-19 affected companies' commitments to supply chain sustainability?

The results of the 2022 Annual State of Supply Chain Sustainability survey and supply chain executive interviews will help answer the above research questions. An understanding of corporate sustainability priorities and commitments has the ability to shape decision making as supply chain professionals aim to invest in sustainable measures. Research on supply chain sustainability origins and growth, social sustainability measures, and the lasting impact of COVID-19 provides a foundation for understanding the current state of sustainability. We are interested in analyzing the survey data to test whether or not there is a significant difference in how groups of people (by age group, gender, language, etc.) interpret their company's or industry's commitments and investments to sustainability. By conducting interviews with supply chain executives across industries, we will gather qualitative context to understand whether the COVID-19 pandemic had long-term impacts on sustainability goals and practices.

There have been several social and environmental events in 2021 that could impact commitments towards sustainability. For example, following the rise of the Black Lives Matter movement across the United States in 2020, supply chain professionals highlighted companies' focus on sustainability efforts regarding employee welfare and equitable work environments (MIT CTL and CSCMP, 2021). The previous year's report shows a year-over-year increase in

commitment to sustainability. Our research will analyze how the commitments and investments to sustainability by companies across industries are interpreted by their employees.

The COVID-19 pandemic increased focus and visibility of supply chains across the world. Companies have realized the importance of sustainable supply chain practices and faced pressures to incorporate sustainability goals at each supply chain level. However, the pandemic also caused significant financial disruptions across industries, which would impact investments made within the supply chain sustainability space.

COVID-19 and recent social justice and environmental movements have changed the world forever, and it is evident that the world is not going back to normal. Companies across industries are adapting to the “new normal,” and we expect them to make significant long-term commitments in their goals and practices to both environmental and social sustainability.

2. LITERATURE REVIEW

2.1 Introduction

This capstone uncovers the current state of sustainability within supply chains across global organizations and industries by analyzing survey responses and interviewing industry professionals for the 3rd Annual State of Supply Chain Sustainability Report. This section presents findings from the previous two State of Supply Chain Sustainability Reports as well as research on the origins of modern sustainability, social sustainability, and the impacts of the COVID-19 pandemic on sustainability commitments.

2.2 Past State of Supply Chain Sustainability Findings

The MIT Center for Transportation and Logistics and Council of Supply Chain Management Professionals initiated the first annual survey to measure sustainability efforts and goals across countries and industries year over year.

The initial sustainability report released in 2020 indicated that companies with sustainability goals had prioritized social sustainability over some environmental sustainability efforts. Noteworthy social sustainability goals included eliminating child labor and forced labor. Although social sustainability is prioritized by companies, investments towards these commitments are lagging compared to environmental sustainability investments (MIT CTL and CSCMP, 2020).

The sustainability report released in 2021 indicated that despite a world-wide pandemic, efforts at and commitment to sustainability did not slow down. Companies made more commitments to goals such as employee welfare and safety, renewable energy, and biodiversity conservation. The areas of focus were influenced by various events such as COVID-19, Black Lives Matter movements and widespread forest fires. Eighty-three percent of executives interviewed in 2020 said that COVID-19 has either accelerated or increased awareness to the field of supply chain sustainability. This push in 2020 was mostly driven by large and very large companies, whereas small and medium sized companies were likely to pull back due to financial strain from the pandemic. The financial impact of COVID affected companies' ability to make tangible investments required to attain the goals and commitments set forward. (MIT CTL and CSCMP, 2021).

2.3 Origins of Modern Sustainability

Modern sustainability concepts can be attributed to “Our Common Future,” more commonly referred to as the “Brundtland Report,” which was issued by the World Commission on Environment and Development (WCED) in 1987. The Brundtland Report defines sustainability as “... not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs” (World Commission on Environment and Development, 1987 pg 17).

In his book, *Cannibals With Forks: The Triple Bottom Line of 21st Century Business*, John Elkington used the phrase “triple bottom line” to outline three dimensions of sustainability: “economic prosperity, environmental quality and – the element which business has tended to overlook – social justice,” (Elkington, 1998, page 2). The triple bottom line is also recognized as three pillars: profit, planet, and people. Using the Triple Bottom Line (TBL) principle as a baseline, Hassini et al. (2012) defined sustainability in supply chain operations as “the management of supply chain operations, resources, information, and funds in order to maximize the supply chain profitability while at the same time minimizing the environmental impacts and maximizing the social well-being.” This perspective sheds light on the impact supply chain and logistics management has on social and environmental well-being, and that efforts towards sustainability practices allow companies to have beneficial impacts to their organization and surrounding communities (Hassini et al., 2012).

To take action on the challenges faced by companies, governments, and organizations in maximizing profit while keeping sustainability top of mind, the United Nations adopted The

2030 Agenda for Sustainable Development in 2015. The Agenda outlines the 17 Sustainable Development Goals (SDGs) that were developed in response to the need for an alignment among economic, social, and environmental sustainability efforts between 2015 and 2030. The Agenda leverages the SDGs as a blueprint for actionable goals that are centered around five pillars: People, Planet, Prosperity, Peace, and Partnership (United Nations, n.d.).

In recent years, nations and organizations have begun to track negative environmental impacts. Organizations spanning from governments to private environmental groups have been developing and using climate-monitoring satellites to track excess or increases in the production of greenhouse gases across the globe (Puko, 2021). Today, the four biggest offenders, responsible for over half of the world's greenhouse gas emissions, in order are China, the United States of America, the European Union, and India (Plumer et al., 2021). Pressures from governments and climate activist groups to cut greenhouse gas emissions have increased, leading to clearly defined CO₂ emission reduction goals for the year 2030 (Plumer & Popovich, 2021).

2.4 Social Sustainability

Social sustainability has been depicted having a threefold scheme: (1) "Development sustainability," addressing basic needs, the creation of social capital, and justice; (2) "Bridge sustainability," concerning changes in behavior to achieve bio-physical environmental goals; and (3) "Maintenance sustainability," referring to preservation of socio-cultural characteristics during change (Vallance et al., 2011). Social sustainability was integrated relatively late into

debates regarding sustainable development and focuses on the protection of all people by fostering adoption of equitable social and environmental policies (Eizenberg & Jabareen, 2017).

The concept of Supply Chain Social Sustainability refers to addressing the social issues within the overall (upstream and downstream) supply chain including suppliers, manufacturers, and customers. Supply Chain Social Sustainability consists of six underlying dimensions: equity, safety, health and welfare, philanthropy, ethics, and human rights. (Mani et al., 2016). Labor equity, health care, safety, and philanthropy are typically viewed as starting points to establish a comprehensive social footprint for a company (Hutchins & Sutherland, 2008). The 2021 SCS report showed that commitment to social sustainability goals went up across the board, specifically in areas like employee welfare and safety. (MIT CTL & CSCMP, 2021)

Although there has not been a strong emphasis on social sustainability in the past, the modern world has increasingly recognized its need and importance (MIT CTL & CSCMP, 2020). Committing to social sustainability is critical in attaining overall sustainability goals. Legislative and corporate actions can be used to effect positive social change, and this is driving the establishment of decision-making tools directed at social impacts (Hutchins & Sutherland, 2008).

2020 and 2021 have been instrumental years for social sustainability and have further highlighted its importance. Major social events, such as the COVID-19 pandemic and the murder of George Floyd, have revealed stark structural and economic injustice prevalent in society (Krieger, 2020). Social events have brought about a wave of social commitments across industries. Companies are actively diversifying their upper management and implementing employee welfare programs. In 2021, U.S. public companies added the most diverse slate of

new directors on record last year, with a surge of Black and women nominees (Glazer, 2021). A study by Spencer Stuart found that S&P 500 companies have 11% more Black directors and 4% more Latino directors than last year (*2021 U.S. Spencer Stuart Board Index*, n.d.). However, similar to what the 2021 SCS report found, these gains are uneven. Smaller companies are lagging behind as compared to their bigger counterparts (Glazer, 2021). New legislative and regulatory shifts have been introduced to ensure social sustainability. For example, the SEC requires that companies explain if they fall short of gender and ethnicity targets on their boards and the State of California requires all in-state companies to have at least one female board director and have requirements in place for racial, ethnic and LGBTQ communities (Fertoli & Glazer, n.d.).

The post-COVID era or “Emergent Age”, a phrase coined by Tim O’Riordan and Alan McGowan, will need to include social justice needs. According to Tim O’Riordan, the pathway to socioeconomic and environmental justice and equity is the most reliable route for achieving the essential environmental permeance of sustainability (O’Riordan et al., 2020). Focusing on and proactively engaging with social sustainability measures is critical for navigating the post COVID-19 era.

2.5 COVID-19 Impacts on Sustainability

The World Health Organization declared the COVID-19 outbreak as a global pandemic in March 2020 (World Health Organization, 2020). In the months following, companies and organizations across the globe faced major disruptions in response to emergency safety measures, global panic, and labor shortages to reduce the spread of COVID-19. Supply chain

professionals across all industries were strained and overwhelmed with the task of adapting to procurement, transportation, and manufacturing delays. The resiliency and flexibility required due to the COVID-19 pandemic sparked insight across sustainable practices in global supply chains. Two areas that may have long-term implications caused by COVID-19 disruptions are technology and social innovations (Sarkis, 2020). Specifically, three characteristics can be pulled from sustainability insights: supply chains may become more resilient with the development of localization, agility, and digitization (LAD) (Nandi et al., 2020). Today, we live in a world where most supply chains are vastly global and include international procurement and logistics measures to increase efficiency and improve margins. As Sarkis summarizes in *Supply chain sustainability: learning from the COVID-19 pandemic*,

“Localized production capability can support sustainable supply chains by producing only what is needed. Less waste, less transportation, and less need for inventory storage due to shorter supply chains; each has sustainable supply chain implications” (Sarkis, 2020). As supply chain professionals across the globe learned to adapt to major disruptions, the value of resiliency and flexibility was made clear.

Measures put in place in response to the pandemic that may have begun as temporary solutions may have long-lasting implications. For example, with the push for social distancing, the options to work remotely or ‘work from home’ became normalized throughout 2020. While some companies may require their employees to return to in-person offices as the pandemic crisis subsides, others may continue to work remotely. While some environmental and social sustainability elements are clear, such as providing increased flexibility and safety for employees and reducing carbon footprints with the decreased commuter travel, other impacts

may offset the sustainability 'wins' (Sarkis, 2020). Remote work may also have negative environmental impacts, such potential higher volumes of air travel for in-person meetings, and decentralized office management, such as the inability for individuals to source 'clean power' to their homes as an office could (Holder, 2021).

We know now that the state of the world will not go back to "normal" once the pandemic subsides; however, the long-term impacts of COVID-19 on supply chain management and sustainability efforts are still unknown. This capstone looks to identify the current state of supply chain management and long-term impacts of COVID-19 are interpreted by different groups of people based on demographics.

2.6 Conclusion

The general concepts of sustainability have been defined over time and pressure has increased regarding the importance and need for environmental and social sustainability across industries. However, little research regarding the current state of sustainability in supply chains existed prior to the efforts made by the MIT Center for Transportation and Logistics in 2019. The results of the 2022 State of Supply Chain Sustainability survey will help gauge the current state by varying demographics. Accompanying interviews with supply chain executives will also help identify the pressures; whether external or internal, that motivate companies to partake in sustainability initiatives. With increasing pressure on corporations to strive for a more sustainable future, the role of supply chain management in the success of sustainability efforts cannot be ignored. With the concepts of sustainable thinking in mind, this capstone will present the current sustainability commitments and priorities of global supply chains.

COVID-19 related impacts and research are currently lacking in the supply chain sustainability space. However, we will identify some short- and long-term impacts of the pandemic using the results from the 2022 survey. It is important to note that since the pandemic is still ongoing, the findings around COVID-19 are expected to change over time. This capstone will present findings regarding how the current state of supply chain sustainability and the long-term impacts brought on by the COVID-19 pandemic are interpreted by different groups of people.

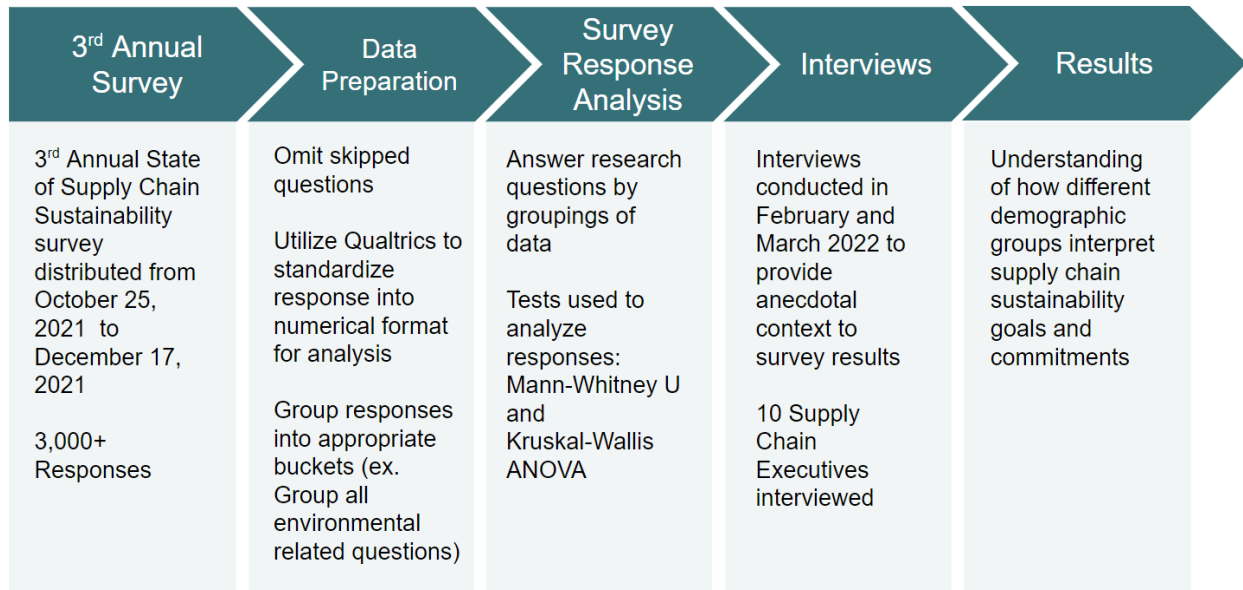
3. METHODOLOGY

We developed an approach consisting of data collection and preparation, survey responses analysis, and interviewing supply chain executives to answer two main research questions by slicing the data into categories (ex. language translation, gender, age range) to see how the different groups interpret sustainability commitments. We performed Mann-Whitney U and Kruskal-Wallis tests to determine if there was significant difference in how the different groups within demographics, no matter the differing sample sizes of the groups, responded to the survey questions. Methodology Approach summary is depicted in Figure 1.

- How do different demographic groups (i.e., gender, language, location, age, and industry) interpret the current state of supply chain sustainability?
- Have the long-term implications of COVID-19 affected companies' commitments to supply chain sustainability?

Figure 1

Methodology Approach



3.1 Survey Data

Data was collected from the responses of the 3rd Annual State of Supply Chain Survey, distributed to supply chain professionals over the course of approximately nine weeks (October 25, 2021 – December 17, 2021). For the first time, this survey was translated into three languages: English, Spanish, and Mandarin Simplified Chinese. Previous year's surveys were only distributed in English, though responses were collected from across the globe.

The survey was created using Qualtrics, a survey software, in 2019 by MIT CTL, in partnership with CSCMP, with a primary goal to understand the SC sustainability practices across industries and locations. The survey was designed to capture aspects such as categories and level of commitment and investment in sustainability, source and level of pressure for sustainability, type of company etc. The questions follow a skip logic, i.e., respondents skip certain questions depending on their response to a parent skip logic question, which helps maintain the quality of responses. The Qualtrics survey was distributed to supply chain

professionals globally using email distribution lists, targeted LinkedIn promotions and social media shares by MIT CTL and sponsors.

3.1.1 Data Cleansing and Preparation

The initial raw data was cleansed in order to make sure answers were complete and there were no unwanted observations that could potentially impact results. The cleansed data helped maintain consistency and accuracy for the subsequent analysis.

We began by omitting any responses before 10/25/21 since that was before the survey was launched and was pre-launch test data. Qualtrics automates some data preparation by returning some survey question results as numerical values for analysis. Prior to analyzing responses by demographic, we took the following measures to remove missing data:

- 64 respondents answered the question “Would you like to continue with the survey?” with “No, I do not wish to continue with the survey.” These responses were removed for analysis.
- If respondents did not answer one or more of the demographic questions (gender, location, language, age range, industry), their responses were not included in the analysis pertaining to that demographic.
- If respondents selected multiple continents as their location, their responses were not included in analysis pertaining to the location demographic.

3.1.2 Social and Environmental Question Consolidation

Survey questions relating sustainability goals, sustainability investments and COVID-19 impact on sustainability had skip-level questions that addressed specific areas of sustainability. The areas were categorized into broad categories: environmental and social sustainability, as categorized in Table 1.

Table 1

Survey Questions Grouped by Social and Environmental Sustainability

Social Sustainability	Environmental Sustainability
<ul style="list-style-type: none">● Employee welfare and safety● Human rights protection● Local community impact● Supplier diversity, equity and inclusion● Fair pay/ fair trade	<ul style="list-style-type: none">● Climate change mitigation● Energy savings/ renewable energy● Water conservation● End of life management/ supply chain circularity● Natural resource and biodiversity conservation

New columns for social and environmental sustainability were added for the questions listed below. The new columns averaged the quantitative survey responses for each of the subsections to produce the final two columns that were used in all further analysis. Survey questions that were answered within the social and environmental sustainability sub-categories are as follows:

- Does your firm have publicly stated sustainability goals related to your supply chain?
- Has your firm invested (financially or with human resources) in increasing the sustainability of your supply chain?

- How has your firm's commitment to supply chain sustainability changed since the start of COVID-19?

3.1.3 Internal and External Pressure Question Consolidation

A similar approach was used to categorize sources of pressure to adopt sustainability practices as either internal or external, as categorized in Table 2.

Table 2

Survey Questions Grouped by Internal and External Sustainability Pressures

Internal Pressures	External Pressures
<ul style="list-style-type: none"> • Current and prospective employees • Company executives 	<ul style="list-style-type: none"> • End consumers • Mass media • Government and international governing bodies • Local communities • Natural resource and biodiversity conservation • Corporate buyers • Investors • NGOs and other third parties • Industry associations

New columns for internal and external sources of pressure were added for the following questions. The columns averaged the quantitative survey responses for each of the subsections to produce the final two columns that were used in all further analysis. The survey question that was answered within the internal and external pressure sub-categories are as follows:

- Does your firm receive pressure to increase sustainability in the supply chain?

After final data preparation and cleaning, more than 3,000 responses were evaluated in our analysis.

3.1.4 Demographic Data Grouping

In order to analyze how different demographic groups interpret and perceive sustainability at their firms/industry and any COVID-19-related impacts, we compared responses by slices of data based on demographics of the respondent. The demographic questions were multiple-choice-style questions on the survey. The different slices of data by demographic that were analyzed are listed in Table 3.

Table 3

Groupings Within Each Demographic Data Category

Data Category	Demographic Data Groupings
Language Translation	<ul style="list-style-type: none"> ● English ● Spanish ● Mandarin Simplified Chinese
Industries	<ul style="list-style-type: none"> ● Agriculture, Forestry, Fishing and Hunting ● Mining, Quarrying, and Oil and Gas Extraction ● Utilities ● Construction ● Manufacturing ● Wholesale ● Retail ● Transportation and Warehousing ● Health Care and Services ● Accommodation and Food Services ● Technology ● Business Consulting ● Academia ● Finance & Accounting ● Other (Please specify) (Open text field)

Gender	<ul style="list-style-type: none"> ● Male ● Female ● Prefer not to say ● Prefer to self-describe (Open text field)
Location	<ul style="list-style-type: none"> ● Africa ● Asia ● Europe ● Latin America and Caribbean ● Mediterranean & Middle East ● North America ● Oceania
Age Range	<ul style="list-style-type: none"> ● 18-24 ● 25-34 ● 35-44 ● 45-54 ● 55-64 ● 65 or older

For the purpose of our analysis, we analyzed the gender demographic by “Male” and “Female” responses only. This is due to the small number of responses that opted as “Prefer not to say” (36 responses) or “Prefer to self-describe” (4 responses).

3.2 Survey Response Analysis

Statistical tests were conducted to understand if groups within each data slice interpret sustainability measures and practices differently. Mann-Whitney U and Kruskal-Wallis tests, further explained in sections 3.2.1 and 3.2.2., respectively, were conducted to see whether the differences in responses were statistically significant; for example, to test if the mean of responses for women is different from the mean of responses from men.

To account for any COVID-19 impact, pandemic-related questions were added to the survey last year. The goal of this addition was to understand the impact of COVID-19 with respect to commitments and investments towards sustainable practices. The Kruskal-Wallis test was conducted to identify any significant differences in gender, industry, age range, language, and location groups with respect to their COVID-19 commitment. Executive interview questions pertaining to COVID-19 impacts were asked again to see changes in responses as compared to last year, the early months of the pandemic.

3.2.1 Mann-Whitney U Test

The Mann-Whitney U test is a nonparametric test that allows two groups to be compared without making the assumption that values are normally distributed. The null hypothesis asserts that the medians of the two samples are identical, and the test provides results related to whether or not the null hypothesis is to be rejected (Whitley, Ball, 2004). A p-value of 0.05 was set to determine statistical significance. This test was conducted for the gender demographic since it included only two independent groups: male and female. The tests were conducted using statistical packages in Python for questions related to sustainability goals, investments, pressures, and COVID-19 impacts. The demographic grouping tested using Mann-Whitney U is shown in Table 4.

Table 4

Demographic Grouping Tested Using Mann-Whitney U

Type of Test	Data Group	Survey Questions
Mann-Whitney-U	Gender	Sustainability goals

	<ul style="list-style-type: none"> ● Male ● Female 	<ul style="list-style-type: none"> ● Likert scale (1-5) <p>Sustainability investments</p> <ul style="list-style-type: none"> ● Likert scale (1-5) <p>Pressures</p> <ul style="list-style-type: none"> ● Likert scale (1-5) <p>COVID-19 impact</p> <ul style="list-style-type: none"> ● Decreased (1) ● Stayed the same (2) ● Increased (3)
--	--	--

3.2.2 Kruskal-Wallis Test

The Kruskal-Wallis test is a nonparametric test that allows two or more groups to be compared without making the assumption that values are normally distributed. The null hypothesis asserts that the medians of the samples are identical, and the test provides results related to whether the null hypothesis is rejected. The test reveals if there is a significant difference between groups (Brewick, Cheek, Ball 2004). A p-value of 0.05 was used to determine statistical significance. This test was conducted for the demographic slices with more than two data groups. The tests were conducted using statistical packages in Python for questions related to sustainability goals, investments, pressures, and COVID-19 impacts. The demographic groupings tested using Kruskal-Wallis are shown in Table 5.

Table 5

Demographic Grouping tested using Kruskal-Wallis

Type of Test	Data Group	Survey Questions
Kruskal Wallis	Language Translation	Sustainability goals

	<ul style="list-style-type: none"> ● English ● Spanish ● Mandarin Simplified Chinese <p>Industries</p> <ul style="list-style-type: none"> ● Agriculture, Forestry, Fishing and Hunting ● Mining, Quarrying, and Oil and Gas Extraction ● Utilities ● Construction ● Manufacturing ● Wholesale ● Retail ● Transportation and Warehousing ● Health Care and Services ● Accommodation and Food Services ● Technology ● Business Consulting ● Academia ● Finance & Accounting <p>Location</p> <ul style="list-style-type: none"> ● Africa ● Asia ● Europe ● Latin America and Caribbean ● Mediterranean & Middle East ● North America ● Oceania <p>Age Range</p> <ul style="list-style-type: none"> ● 18-24 ● 25-34 ● 35-44 ● 45-54 ● 55-64 ● 65 or older 	<ul style="list-style-type: none"> ● Likert scale (1-5) <p>Sustainability investments</p> <ul style="list-style-type: none"> ● Likert scale (1-5) <p>Pressures</p> <ul style="list-style-type: none"> ● Likert scale (1-5) <p>COVID-19 impact</p> <ul style="list-style-type: none"> ● Decreased (1) ● Stayed the same (2) ● Increased (3)
--	---	--

3.2.3 Testing Across Multiple Demographics

The initial tests performed on each demographic group allowed us to discover if there is a significant difference in responses. To take our analysis one step further, we reviewed our

results, and where responses showed significant differences, we re-grouped the demographics under single industry categories. This additional testing is performed to understand if there is consistently a significant difference in survey response when the respondents belong to the same industry. For this additional testing, we decided to look at the gender, location, and age range under the three largest, supply chain-related industries: Manufacturing, Transportation & Warehousing, and Retail. For example, we took the sample of respondents who indicated they were in the manufacturing industry and tested this sample under the gender demographics: male and female.

3.3 Executive Interviews

Executive Interviews were conducted in February and March 2022, with supply chain executives from different industries, geographic locations, gender, and age. The objective of the interviews was to gain context around survey data and results, insights into the impact of the COVID-19 pandemic, and action items that can be suggested to readers of the report.

Conducted virtually, interviews were semi-structured and consisted of open-ended questions. Executive Interview questions for the 2021 State of Supply Chain Sustainability Report are listed in Table 6. The interview questions focused on topics such as current SC sustainability priorities and barriers, sources of pressure to adopt sustainable practices, COVID-19 impacts to sustainability commitments etc. and helped get a qualitative approach to our study. Interview responses were also used as anecdotes to accompany the data.

Table 6

Executive Interview Questions for 2021 State of Supply Chain Sustainability Report

Executive Interview Questions

- In your view, how important is SC sustainability in your industry? How might this change in the next five years?
- Do you think the pressure has increased for companies to pursue SC sustainability? Recently, in the last five or ten years, or not at all? Please explain your answer.
- What role do SC professionals generally play in pursuing sustainability? How can they make a difference in this space?
- In your industry, what distinguishes the most progressive companies in terms of their SC sustainability programs?
- Which areas of SC sustainability – e.g., labor, emissions, waste, water use – are afforded the highest priority in your company and industry?
- What are the biggest barriers to supply chain sustainability success and the practices that are the hardest to implement in your industry and company?
- Are there emerging technologies that you feel will play a role in enabling SC sustainability? If so, what are those technologies?
- How has COVID – 19 impacted SC sustainability programs in your industry and company, if at all? Do you think these impacts will be permanent?
- Do you think any demographics play a role in how people view and prioritize SC sustainability?
- What was your firm's first step on its supply chain sustainability journey? If someone reading this report from your industry is motivated to take action, what do you suggest they do first? How did your first steps go for you?

4. RESULTS

The following section presents the results from analysis conducted on the State of Supply Chain Sustainability survey responses. Our results outline the number of responses we received from each demographic group analyzed, as well as the insights identified through the Mann-Whitney U and Kruskal-Wallis tests performed on the data. Data visualization software within Python was used to display the test results as histograms. In order to understand the

respondent sample, we used data visualization capabilities in Microsoft Excel to see their general composition in terms of location, gender, age range, language and industry.

4.1 Respondent Summary

The 2022 SCS survey received over 3,300 responses, a record high for the Annual SCS survey. All survey questions indicating demographic information (with the exception of the language translation of the survey) were optional, but approximately half of the survey respondents identified their demographics, allowing our team the ability to conduct meaningful analysis on a sample of the survey. Appendix A illustrates the complete distribution of respondents by each demographic group.

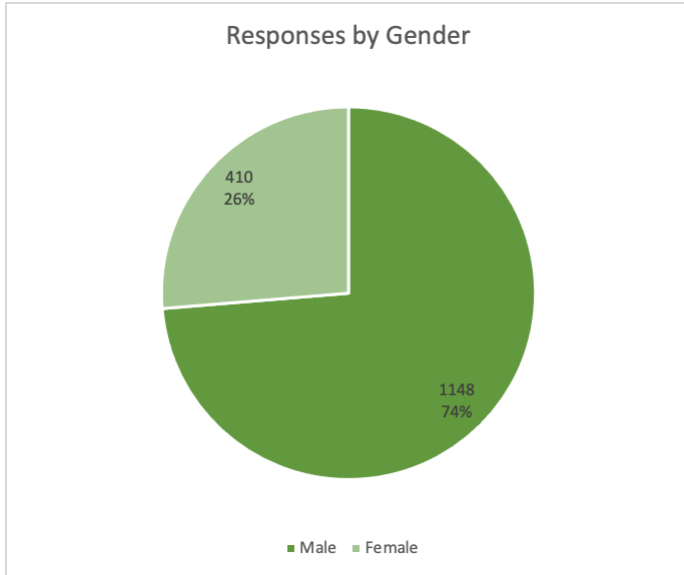
The following summary displays the number of responses by demographic category after data-cleansing was completed.

4.1.1 Gender

Through the responses to the survey question indicating gender identification, we were able to analyze 1,558 responses using the Mann-Whitney U test; 1,754 collected survey responses chose not to answer this question, and therefore we were unable to include it in our analysis. Gender demographics for respondents of the 2022 SCS survey included in our analysis are depicted in Figure 2.

Figure 2

Number of Responses by Gender

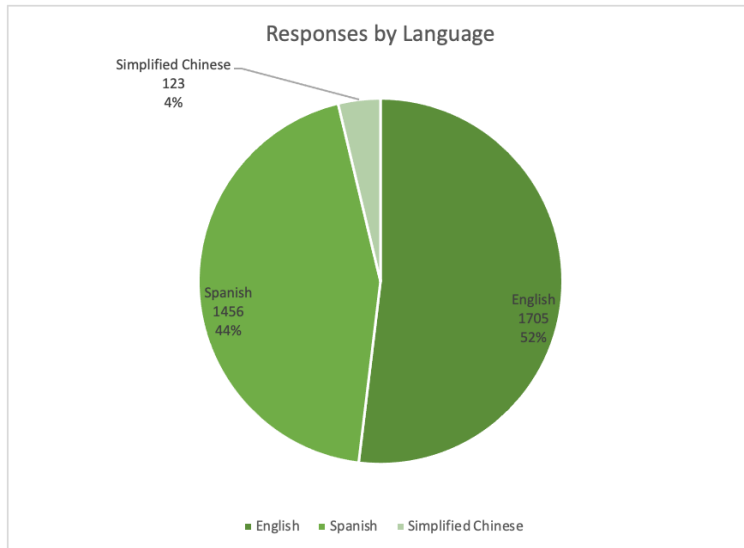


4.1.2 Language Translation

For the first time, the survey was translated and distributed in three languages; English, Spanish, and Mandarin Simplified Chinese. The survey required that all respondents select the language translation prior to proceeding, and of all responses, we received 1,738 in English (EN), 1,475 in Spanish (ES), and 122 in Mandarin Simplified Chinese (ZH-S), depicted in Figure 3.

Figure 3

Breakdown of Survey Responses by Language

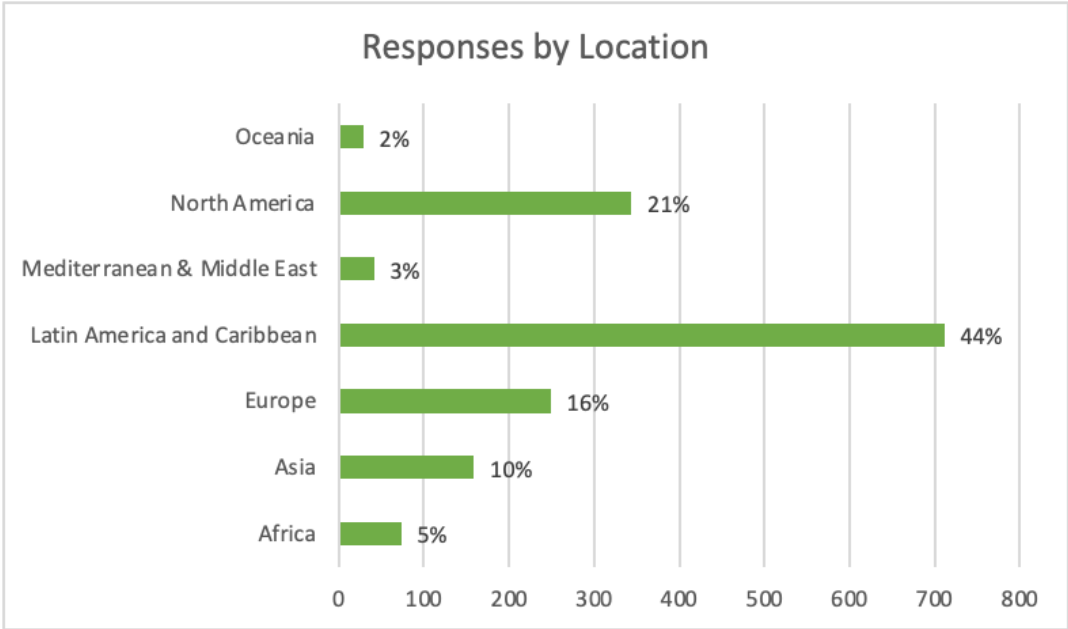


4.1.3 Location

The survey consisted of respondents with headquarters located in all regions: North America, Latin America and Caribbean, Asia, Africa, Europe, Mediterranean and Middle East, and Oceania. Unlike previous years wherein North America had the majority of respondents, the number of responses from the Latin America and Caribbean region outnumbered those of North America. Latin America and Caribbean comprised 44% of the respondents, followed by North America, which comprised 21.4% of the respondents. Location demographics for respondents of the 2022 SCS survey included in our analysis are depicted in Figure 4.

Figure 4

Number of Responses by Location

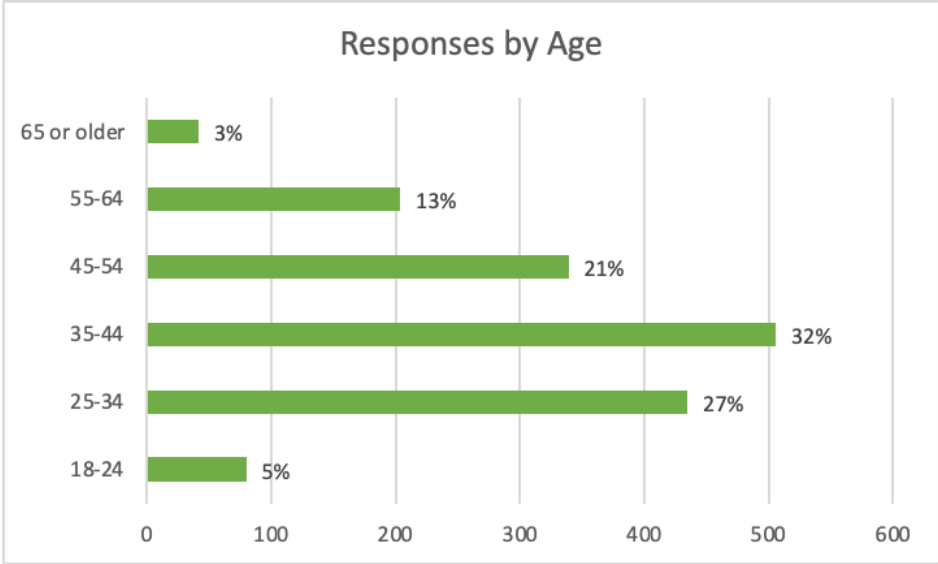


4.1.4 Age Range

In total, 1,606 respondents indicated their age within the survey. Though respondents spanned all age-range options given, the bulk of responses were completed by people aged 15-54 years. The breakdown by each age group is depicted in Figure 5.

Figure 5

Number of Responses by Age Range

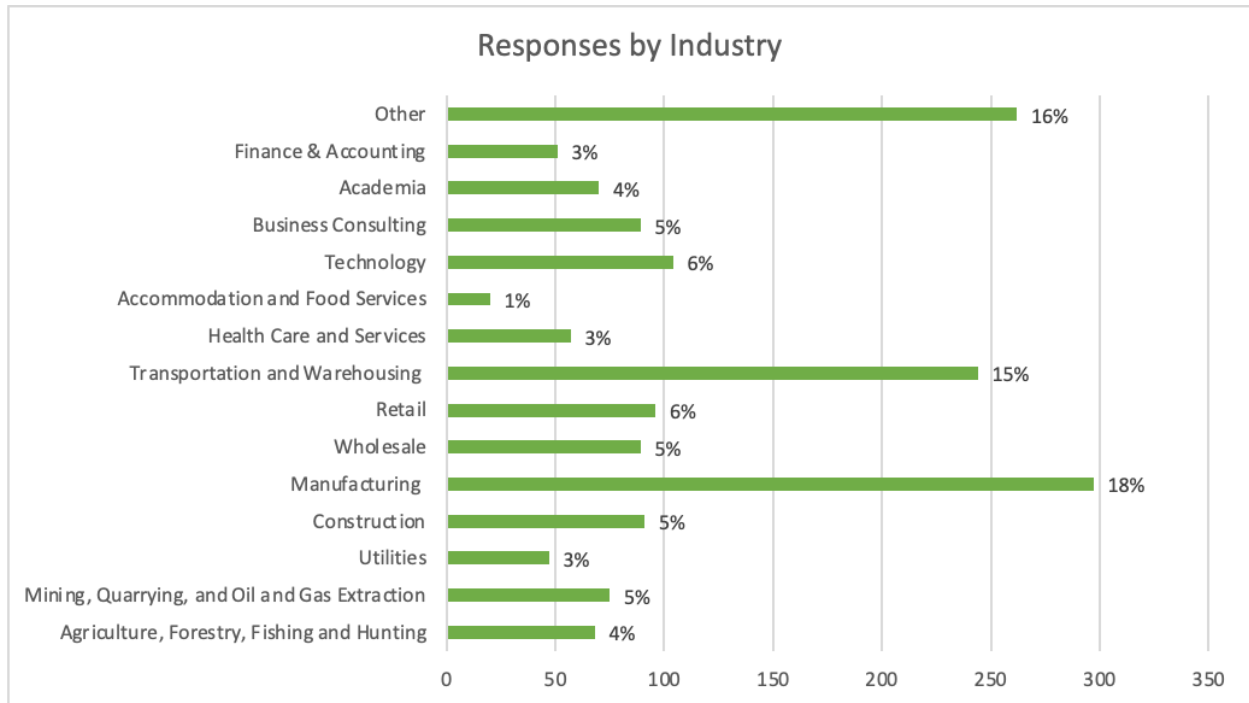


4.1.5 Industry

The survey consisted of respondents across industries, including Agriculture, Mining, Utilities, Construction, Manufacturing, Wholesale, Retail, Transportation and Warehouse, Health Care etc. Supply Chain focused industries like Manufacturing comprised 18%, Transportation and Warehousing comprised 15% and Retail comprised 6% of respondents that self-identified their industries. Industry demographics for respondents of the 2022 SCS survey included in our analysis are depicted in Figure 6.

Figure 6

Number of Responses by Industry



4.1.6 Executive Interviews

Ten supply chain executives were interviewed between February and March of 2022 to add context to the results found in the State of Supply Chain Sustainability survey responses. We asked each of the interviewees to fill out a form indicating their demographic information. This form was optional, and therefore not all interview records contain demographic information. Of the executives who voluntarily provided demographic information, demographics are as follows:

- Gender: Three executives identified as male, two as female.
- Language Translation: All interviews were conducted in English.
- Location: All executives are located in North America.
- Age Range: Ages of executives covered the range between 25-64.

- Industry: The range of industries included Technology, Wholesale, Transportation & Warehousing, Manufacturing, and Pallets/Packaging.

4.2 Test Results by Demographic

The following results using the Mann-Whitney U and Kruskal-Wallis test indicated whether there is a significant difference in how questions from the State of Supply Chain Sustainability survey were answered based on demographic groupings.

4.2.1 Gender

The results from our nonparametric Mann-Whitney U tests for responses by gender showed statistically significant differences (with a p-value less than .05) are listed in Table 7 and visualized in Figure 7, Figure 8, and Figure 9.

Table 7

Significant Differences in Responses by Gender

Survey Question	Significance Value (reject the null hypothesis)
SCS Goals - Environmental	0.013
SCS Goals - Social	0.017
SCS Investments - Environmental	0.000
SCS Investments - Social	0.000
COVID-19 Impact on SCS Commitment - Environmental	0.007
COVID-19 Impact on SCS Commitment - Social	0.027

Figure 7

Significance - SCS Environmental & Social Goals - Response Difference by Gender

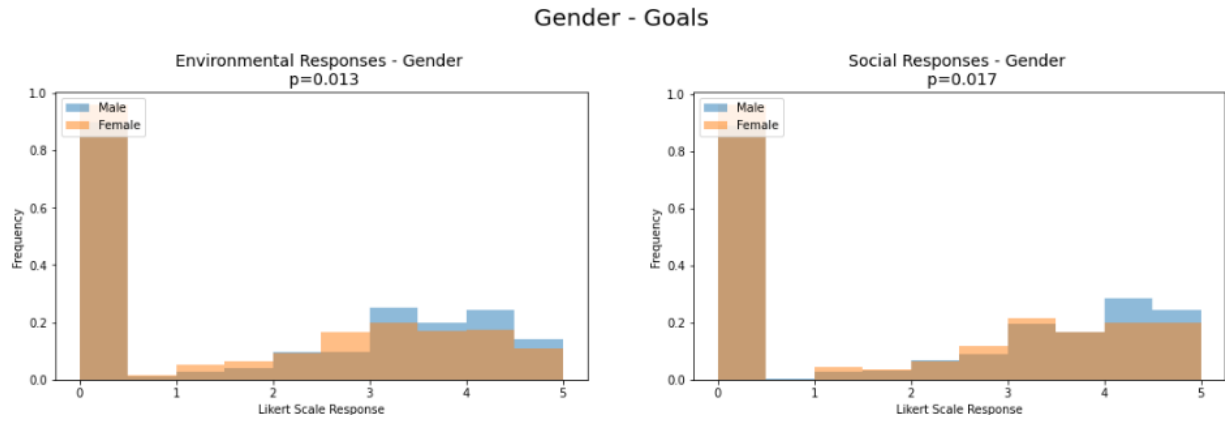


Figure 8

Significance - SCS Environmental & Social Investments- Response Difference by Gender

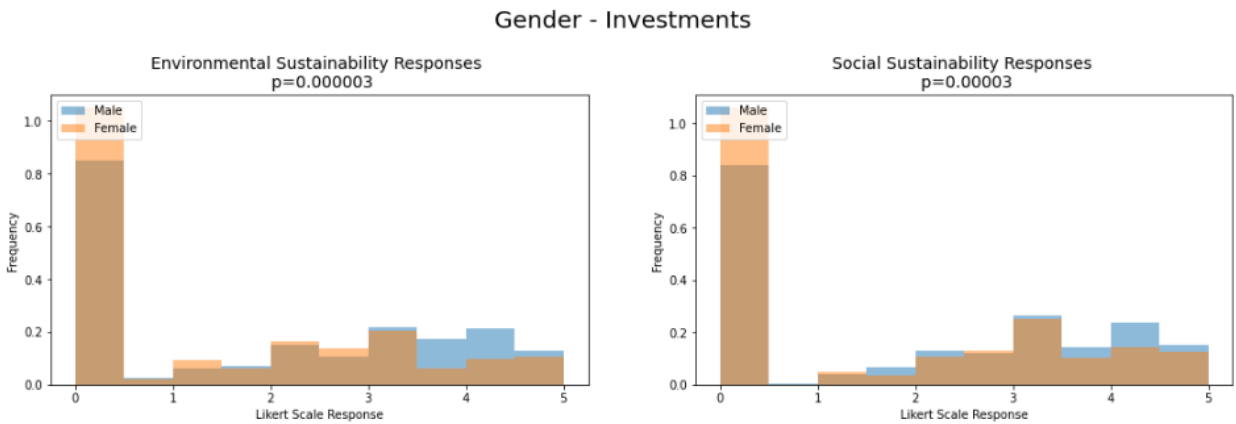
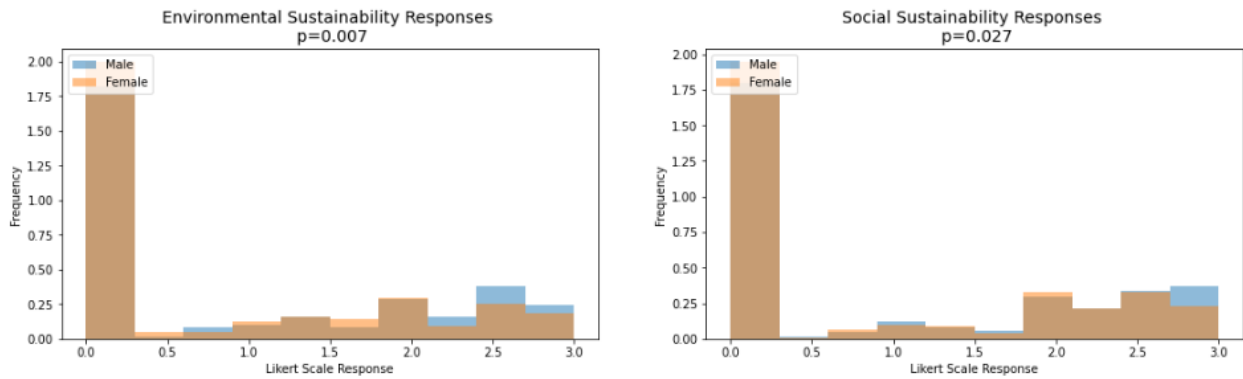


Figure 9

Significance - COVID-19 Impact on Environmental & Social SCS Commitments - Response Difference by Gender

Gender - COVID19 Commitment Impact



4.2.2 Language Translation

The results, listed in Table 8, from our nonparametric Kruskal-Wallis tests for responses by language showed significant differences (with a p-value less than .05) in the following areas:

Table 8

Significant Differences in Responses by Language Translation

Survey Question	Significance Value (reject the null hypothesis)
COVID-19 Impact on SCS Commitment - Environmental	0.031
COVID-19 Impact on SCS Commitment - Social	0.013

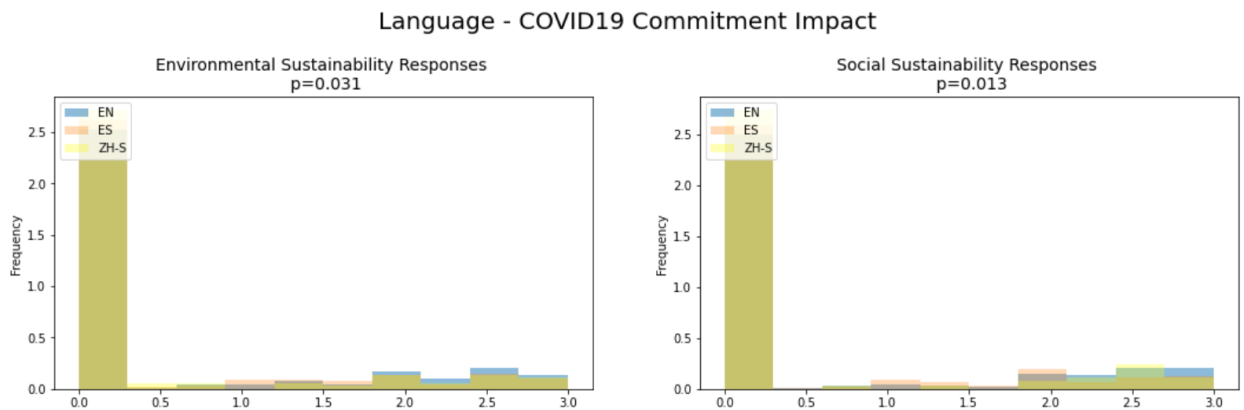
The Kruskal-Wallis tests on Language Translation told us that people who spoke different primary languages responded differently to questions regarding their companies' commitments to COVID-19. To gain an understanding on what these differences in responses looked like, we first wanted to see of those who believed COVID-19 commitments were applicable to their country, if they believed their companies' commitments decreased (likert

response value: 1), stayed the same (likert response value: 2) or increased (likert response value: 3) in 2021. Once we removed “0 - Not Sure/Not Applicable” responses, the average responses of COVID-19 Impact on SCS Commitment - Environmental from English-speaking respondents was 2.06, from Spanish-speaking respondents was 1.86, and from Chinese-speaking respondents was 1.92. The average responses of COVID-19 Impact on SCS Commitment - Social from English-speaking respondents was 2.22, from Spanish-speaking respondents was 1.96, and from Chinese-speaking respondents was 2.2. The results are depicted in Figure 10.

Figure 10

Significance - COVID-19 Impact on Environmental & Social SCS Commitments - Response

Difference by Language Translation



4.2.3 Location

The results, listed in Table 9, from our nonparametric Kruskal-Wallis tests for responses by continent showed significant differences (with a p-value less than .05) in the following areas:

Table 9

Significant Differences in Responses by Location

Survey Question	Significance Value (reject the null hypothesis)
SCS Goals - Environmental	0.011
SCS Goals - Social	0.021
SCS Investments - Environmental	0.001
SCS Investments - Social	0.004

4.2.4 Age Range

The results, listed in Table 10, from our nonparametric Kruskal-Wallis tests for responses by age range showed significant differences (with a p-value less than .05) in the following areas:

Table 10

Significant Differences in Responses by Age Range

Survey Question	Significance Value (reject the null hypothesis)
SCS Goals - Environmental	0.027
SCS Goals - Social	0.017
SCS Pressures - Internal	0.013
SCS Pressures - External	0.013

4.2.5 Industry

The results, listed in Table 11 from our nonparametric Kruskal-Wallis tests for responses by industry showed significant differences (with a p-value less than .05) in the following areas:

Table 11

Significant Differences in Responses by Industry

Survey Question	Significance Value (reject the null hypothesis)
SCS Goals - Environmental	0.000
SCS Goals - Social	0.004
COVID-19 Impact on SCS Commitment - Environmental	0.002
COVID-19 Impact on SCS Commitment - Social	0.002

4.2.6 Testing Across Multiple Demographics

Initial analysis resulted in 14 instances where there were significant differences in response totals for three demographics: gender, location, and age range. We then identified three major industries (Manufacturing, Transportation & Warehousing, & Retail) and isolated the demographics (gender, location, and age range) within each to identify questions where initial analysis showed significant differences. This presented 42 instances to re-test for significant differences in responses. We performed Mann Whitney-U and Kruskal Wallis tests on the 42 combinations of gender, location, and age range when isolated by the same industry, and only 8 instances resulted in significant differences in responses, as shown in Appendix B. Within the Manufacturing, and Transportation & Warehousing industries, only gender and location demographics showed significant differences in responses and Age Range demographic showed no significant differences in responses, i.e., having a p-value of less than 0.05. Within the Retail industry, none of the demographics resulted in significantly different responses.

5. QUALITATIVE FINDINGS FROM EXECUTIVE INTERVIEWS

In addition to the context provided by the overall state of supply chain sustainability, the supply chain executive interviews provided qualitative perspectives on the long-term impacts, or lack thereof, of the COVID-19 pandemic on supply chain sustainability. The supply chain executives interviewed consistently responded that supply chain sustainability was important in their industries and would remain so over the next five years. The executives indicated that focus on commitments and pressures to operate sustainably have increased in recent years, and we heard consistently from executives that companies that don't have sustainability targets are already behind the curve. This section outlines key takeaways that were brought up consistently during the interviews.

I. Goals and Pressures: All supply chain executives indicated that supply chain sustainability goals are being set across industries due to both external and internal pressures.

Additionally, goals and pressures around sustainable supply chain practices are expected to increase in the next five years.

- *“Seeing more and more that customers are expecting it and, in some cases, demanding it. Customers are looking to purchase from companies that have sustainability commitments.” - Manufacturing Industry, North America*
- *“Pressure and goals start from the top down. The differentiator is when we have creative and motivational goals that are set at the highest level possible, then funding and projects rally behind that goal. We see struggles when there are grassroots efforts.” - Manufacturing Industry, North America*
- *“In some respects, we are required to adopt sustainable practices due to government policy. The Government can push large corporations into being more*

sustainable and it trickles down.” - Male, Age 45-54, Pallets/Packaging Industry, North America

- *“Shareholders ask questions - what is the roadmap and plan to get there, and are you making progress along the way? It’s important for investors, and the financial industry is very engaged.” - Wholesale Industry, North America*
- *“Once something has been brought to the forefront of people’s attention, it’s hard to fall out. There have been certain things in the ESG space that have been uncovered, and I don’t think investors are going to forget about that. Importance will only increase.” - Finance & Accounting Industry, North America*

II. Role of Technology: While the types of technologies differed, all executives indicated that emerging technologies would play a role in the enablement of supply chain sustainability. Some of the technologies and concepts mentioned included alternative fuel alternatives in transportation, the digitalization of supply chains, platforms to increase the traceability, visibility, and collaboration across multiple stakeholders, warehouse automation, and intelligent load and route optimization technologies.

- *“COVID-19 was a wakeup call for many companies. The ones that weren’t making investment in automation are now trying to catch up. Visibility and supplier performance aren’t totally implemented in the market yet.” - Male, Age 55-64, Technology Industry, North America*
- *“Biggest step changes are going to come with digitization of supply chains.” - Male, Age 45-54, Pallets/Packaging Industry, North America*

- *“Data will continue to be important. We also need to use it to measure progress.”*
- Female, Age 25-34, Technology Industry, North America

III. COVID-19 Impacts: All executives commented that they believe impacts to sustainability commitments and priorities in response to COVID-19 disruptions would continue into the future, even as pandemic restrictions loosen.

- *“The world got a wakeup call during the pandemic, and everyone had to learn how to run thin. The pandemic was a wakeup call for sustainability.”* - Male, Age 55-64, Technology Industry, North America
- *“COVID-19 has accelerated a lot of things in sustainability but also put a lot of stress on supply chains and forced them to be more efficient. I don’t think people want to go back; I think a lot will stay.”* - Technology Industry, North America
- *“COVID-19 has really forced companies to value humans more. That’s something that has given workers more influence and power. I think there will be lasting shifts in how workers are treated and what they can reasonably expect. The pandemic put the supply chain in focus and is very much in the public eye which translates to public interest.”* - Finance & Accounting Industry, North America
- *“COVID was a turning point – people who didn’t have to think about supply chains had to think about it. It caused people to ask questions.”* - Finance & Accounting Industry, North America
- *“The pandemic showed how fragile supply chains can be. One aspect that is highlighted is resilience. More companies are looking at how to build resilience into supply chains by diversifying supplier, localizing production. The social aspect*

as well - more people are now aware of this. It's not an either-or conversation." -

Female, Age 25-34, Technology Industry, North America

IV. Role of Demographics: Of the 10 supply chain executives interviewed, eight indicated that they believe demographics may play some role in how people view and interpret sustainability in supply chain management.

- *"Supply Chain has been a painfully old boys' network; however you see more and more female executives in the supply chain world... It's an area where up and coming generations can have huge contributions because of the level of expectations."* - Male, Age 55-64, Technology Industry, North America
- *"It is the nature of people to be influenced by the people around them and the content they view on a daily basis."* - Female, Age 25-34, Technology Industry, North America
- *"Great thing about young people is the mindset at a younger age compared to my generation is so much more advanced about caring about environmental impact. My generation is catching up but it's taking a bit longer to get there."* - Wholesale Industry, North America
- *"I'm increasingly seeing more women in the ESG space. Supply Chain has historically been male dominated, so it's interesting to see their perspectives."* - Female, Age 35-44, Wholesale Industry, North America
- *"Without a doubt, demographics play a role in sustainability interpretation. People who grew up in this industry who were only focused on cost are headed out. Younger people are coming in who care about the environment and this*

forces people to innovate.” - Male, Age 45-54, Transportation & Warehousing Industry, North America

V. Value Proposition: Five executives indicated a business case for adopting sustainability practices, and the potential to provide a competitive advantage, positive impact to the bottom line, and distinction as industry leaders. They commented that sustainability is no longer optional, but instead, necessary for the success of a company.

- *“If companies can’t learn to run efficiently, they run the risk of being put out of business by disruption and competitors... If all companies optimize inventory, it would liberate trillions of dollars of working capital to allow them to invest in social measures. Everybody wins.” - Male, Age 55-64, Technology Industry, North America*
- *“The bottom-line aspect to sustainability is interesting - reducing carbon footprint by reducing gas usage also reduces cost.” - Logistics Industry, North America*
- *“If you aren’t thinking about sustainability in your business, you’re already behind.” - Female, Age 25-34, Technology Industry, North America*
- *“The benefit to people, planet, and profit has been highlighted. - In the past the focus was on the planet, but now we are seeing that there is a greater benefit to more than just the planet: benefits to the bottom line.” - Manufacturing Industry, North America*

6. DISCUSSION

The following section will discuss our insights regarding how well demographics explain the difference in how people understand and interpret supply chain sustainability, based on results from survey response analysis and executive interviews.

6.1 Current State of Supply Chain Sustainability

In order to understand the current state of supply chain sustainability, it is important to keep in mind the general environmental and social sustainability climate in 2021.

The COVID-19 pandemic continued to cause major disruptions across the world, and further highlighted glaring social inequalities around the world. The world felt a glimmer of hope with the rollouts of the COVID-19 vaccine in 2021, however this distribution was found to be unequally distributed to privileged countries and communities (Melillo, 2021). Accessibility to vaccines also led to debates and decisions around mandating vaccines to ensure workplace safety.

Major supply chain disruptions caused by the pandemic in 2020 were further exacerbated due to changes in consumer behavior, constraints, and challenges across all degrees of supply chain globally. The focus on supply chains continued to increase owing to disruptions caused by the pandemic, obstruction of the Suez Canal by container ship *Ever Given*, and severe port congestion.

The United States elected a new president who restored relationships with the World Health Organization and the Paris Climate Agreement. The country restored its priorities towards fighting climate change and its goal to limit global warming to preferably 1.5 degree Celsius, compared to pre-industrial levels. Additionally, the UN Climate Change Conference was

held in November wherein nations made new pledges on methane gas pollution, deforestation, and coal financing, as well as a completion of long-awaited rules on carbon trading.

The world also faced several climate events such as recording the Earth's warmest month in recorded history, massive ice melting event in Greenland during a heat wave in the Arctic and hurricanes that occurred with unprecedented frequency and severity.

6.2 Variation in Responses by Demographic

The third State of Supply Chain Sustainability survey resulted in significant differences in responses across demographic groups. Of the five demographic groups, four showed differences in responses for questions concerning SCS goals, three showed response differences for COVID-19 related questions, two had differences in SCS investments, and only one demographic group showed significant difference in responses concerning SCS pressures. We noticed that in all cases where significant differences were found in responses to particular questions, there were always differences in both categorical variations of the question (e.g., SCS Goals - Environmental and SCS Goals - Social).

Under this initial analysis, demographics at least partially explained the difference in how people understand and interpret supply chain sustainability. However, we wanted to confirm if these demographic differences in responses still exist among people with similar work environments. To take our analysis one step further, we continued isolating demographics by testing for differences in responses within the same industry. When analyzing within the three largest supply chain-related industries by number of responses – manufacturing, transportation and warehousing, and retail – fewer responses from the gender, age range, and

location demographics showed significant differences. This tells us that the understanding and interpretation of sustainability is more consistent within industries. Based on our analysis, we learned that it may not necessarily be a person's demographics, such as gender or age, but a person's work environment that has a greater impact on their understanding and perception of supply chain sustainability. There may be opportunities for industry groups to define sustainability practices and goals and look to educate employees on sustainability at an industry-wide level.

6.3 Long-Term Implications of COVID-19

Through interviewing supply chain executives across industries, we set out to gain context and perspectives on if and how the long-term implications of COVID-19 affected companies' commitments to supply chain sustainability. All ten of the executives commented that yes, the changes and awareness of supply chain management and sustainability brought on by the pandemic would not be going away any time soon. Some of the key takeaways from these interviews included the following:

- The pandemic highlighted the fragility of supply chains and required companies to redesign their supply chain networks to be more focused on resilience, and no longer solely focused on single-sourcing or choosing the cheapest options. Resiliency can be increased with strategies to diversify suppliers or localize production.
- The effects of the pandemic accelerated advancements in sustainability, such as working remotely to enable collaboration and forcing supply chains to be more efficient by reducing on-hand inventory.

- The increase in visibility and awareness of supply chain management in the public eye will increase the focus and attention on bringing new, innovative sustainability solutions to supply chain practices.

6.4 Limitations

While we were able to discover which groups responded differently than others through our analysis, certain limitations in our study prevented further investigation. This section details the key limitations we encountered during our research.

6.4.1 Respondent Sample

The survey is sent out to supply chain professionals using targeted LinkedIn posts, mailing lists and targeted advertisements. The respondents are anonymous, and we assume that they reflect and represent the company or firm they work for. The survey poses questions on how they interpret sustainability within their firms and that could vary from their personal opinions toward sustainability.

6.4.2 Optional Demographic Questions

Our capstone focuses on understanding how different demographic groups like age, gender, industry, language, and location interpret the current state of sustainability. However, all demographic-related questions except language were optional. Approximately half of all survey respondents did not fill out some or all demographic related questions. For the purposes

of our study, the respondents that didn't answer specific demographic questions were omitted from analysis related to that demographic.

6.4.3 Survey Limitations

Our capstone relies on survey responses to assess and understand the current state of supply chain sustainability. However, it is important to note that survey responses may not accurately reflect reality. Sustainability research has shown that people tend to respond highly positively to sustainability questions on surveys, however, the same people don't necessarily act that way due to the additional costs and efforts involved. Therefore, it is important to keep in mind that this capstone reflects only survey responses, and not tangible actions taken by people/companies.

6.5 Recommendations

Looking at sustainability goals and priorities at a broad level is a good starting place for people to understand issues facing the world today and frame guidelines to target those issues. For example, many companies and organizations utilize the United Nations 17 Sustainable Development Goals (SDGs) as a framework when creating their own sustainability goals (United Nations, n.d.). Broad or global goals such as these are a good starting point for many and provide the means for greater public awareness. However, when it comes to acting on goals, industry-specific guidance may serve as a more focused approach to goal setting that could allow companies to be more intentional about their supply chain sustainability goals. Organizations and companies within the same industry could improve their supply chain

sustainability best practices by using their industry expertise (i.e., the knowledge of traditional practices, understanding of the future of the industry, and first-hand experience with some of the pain-points and issues that are specific to an industry. For organizations looking to focus their supply chain guidelines and standards, we recommend the following:

- Narrow down sustainability goals by industry. Find industry partners that are looking to collaborate and share expertise and experiences to make more meaningful strides towards industry-wide sustainability targets.
- Improve best practices by sharing supply chain sustainability guidelines and make benchmarking comparisons by industry.

For future studies into demographic differences in the interpretation of supply chain sustainability, we recommend the following to reduce limitations in research:

- **Respondent sample:** Further research on how different demographic groups interpret supply chain sustainability could collect a sample of all demographics (gender, age range, and location) from the same company. The company's goals and commitments would be the same for all respondents, therefore level of interpretation would be for a single company at a time, and proper comparison could be performed with the same baseline.
- **Optional demographic questions:** Making the demographic questions within the survey mandatory would allow for a greater sample of data to analyze.
- **Further analysis using different data slices:** Our capstone did an in-depth analysis of demographic differences within Manufacturing, Retail and Transportation &

Warehousing industries. A similar approach could be used for different control factors and data slices to understand differences within certain sub-groups.

7. CONCLUSION

Supply chain sustainability is understood and interpreted differently by people. We investigated if demographics explained these differences through two research questions:

1. How do different demographic groups (i.e., gender, language, location, age, and industry) interpret the current state of supply chain sustainability?
2. Have the long-term implications of COVID-19 affected companies' commitments to supply chain sustainability?

We determined that when analyzing responses of the third annual State of Supply Chain Sustainability survey by demographic groups – gender, location, age range, industry, and language translation – results showed significant differences in response within each grouping. Initial analysis of these demographics alone explained some of the difference in how people interpreted supply chain sustainability; however, when isolating groups further, this became less apparent. Upon isolating the gender, age range, and location demographics by major supply chain industries, fewer responses showed significant differences. From this, we can conclude that focusing on supply chain sustainability definitions and guidelines for future researchers should be industry-specific, rather than specific to demographics such as gender, age, or location.

As public awareness of climate change and social sustainability grows, and global disruptions such as the COVID-19 pandemic continue to have lasting impacts, it's imperative for

organizations to take a meaningful approach to developing sustainability goals and commitments. Industry may be the most important building block in defining the difference in how people understand the state of supply chain sustainability. The analysis or benchmarking of sustainability best practices in future research could be improved by comparing within industries. Further research on how people understand and interpret supply chain sustainability has the potential to shape industry-wide sustainability targets and definitions. These “industry-standard” targets and definitions could be used to educate company employees, executives, and even customers on the company’s supply chain sustainability goals and commitments. Industry players could work together by sharing expertise on sustainability goals to develop a comprehensive and industry-collaborative approach to establishing sustainability best practices and informing how sustainability definitions are developed, specific to their industry.

References

- 2021 U.S. Spencer Stuart Board Index. (n.d.). SpencerStuart. Retrieved October 29, 2021, from <https://www.spencerstuart.com/research-and-insight/us-board-index>
- Bewick V, Cheek L, Ball J. Statistics review 10: further nonparametric methods. *Crit Care*. 2004;8(3):196-199. doi:10.1186/cc2857
- Eizenberg, E., & Jabareen, Y. (2017). Social Sustainability: A New Conceptual Framework. *Sustainability*, 9(1), 68. <https://doi.org/10.3390/su9010068>
- Elkington, J. (1998). *Cannibals With Forks: The Triple Bottom Line of 21st Century Business*. New Society Publishers.
- Fertoli, A., & Glazer, E. (n.d.). *Are Corporate Boards Heeding Pressure to Diversify?* Retrieved October 28, 2021, from <https://www.wsj.com/podcasts/google-news-update/are-corporate-boards-heeding-pressure-to-diversify/c95c3653-3ed9-465a-b0c4-6e9a625183ad>
- Francis, T and Glazer, E. (2021, October 19). WSJ News Exclusive | Newest Class of Corporate Directors Is the Most Diverse Yet, but Gains Are Uneven. *Wall Street Journal*. <https://www.wsj.com/articles/newest-class-of-corporate-directors-is-the-most-diverse-yet-but-gains-are-uneven-11634644801>
- Hassini, E., Surti, C., & Searcy, C. (2012). A literature review and a case study of sustainable supply chains with a focus on metrics. *International Journal of Production Economics*, 140(1), 69–82. <https://doi.org/10.1016/j.ijpe.2012.01.042>
- Holder, S. (2021, March 29). The Environmental Implications of the Return to the Office. *Bloomberg.Com*. <https://www.bloomberg.com/news/articles/2021-03-29/is-telecommuting-really-greener-it-depends>
- Hutchins, M. J., & Sutherland, J. W. (2008). An exploration of measures of social sustainability and their application to supply chain decisions. *Journal of Cleaner Production*, 16(15), 1688–1698. <https://doi.org/10.1016/j.jclepro.2008.06.001>
- Krieger, N. (2020). ENOUGH: COVID-19, Structural Racism, Police Brutality, Plutocracy, Climate Change—and Time for Health Justice, Democratic Governance, and an Equitable, Sustainable Future. *American Journal of Public Health*, 110(11), 1620–1623. <https://doi.org/10.2105/AJPH.2020.305886>
- Mani, V., Agarwal, R., Gunasekaran, A., Papadopoulos, T., Dubey, R., & Childe, S. J. (2016). Social sustainability in the supply chain: Construct development and measurement validation. *Ecological Indicators*, 71, 270–279. <https://doi.org/10.1016/j.ecolind.2016.07.007>
- MIT Center for Transportation & Logistics and Council of Supply Chain Management Professionals. (2020). *State of Supply Chain Sustainability 2020*. MIT Center for Transportation & Logistics.
- MIT Center for Transportation & Logistics and Council of Supply Chain Management Professionals. (2021). *State of Supply Chain Sustainability 2021*. MIT Center for Transportation & Logistics.
- Melillo, G. (2021). Disparities in COVID-19 Vaccine Rates Tarnish Swift US Rollout. *AJMC*. <https://www.ajmc.com/view/disparities-in-covid-19-vaccine-rates-tarnish-swift-us-rollout>

- O’Riordan, T., McGowan, A. H., Cutter, S., Hamann, R., & Lahsen, M. (2020). Reframing Sustainability in the Emergent Age. *Environment: Science and Policy for Sustainable Development*, 62(6), 2–7. <https://doi.org/10.1080/00139157.2020.1820291>
- Plumer, B., Migliozi, B., & Popovich, N. (2021, November 1). How Much Are Countries Pledging to Reduce Emissions? *The New York Times*. <https://www.nytimes.com/interactive/2021/11/01/climate/paris-pledges-tracker-cop-26.html>
- Plumer, B., & Popovich, N. (2021, April 22). The U.S. Has a New Climate Goal. How Does It Stack Up Globally? *The New York Times*. <https://www.nytimes.com/interactive/2021/04/22/climate/new-climate-pledge.html>
- Puko, T. (2021, October 19). Who Are the World’s Biggest Climate Polluters? Satellites Sweep for Culprits. *Wall Street Journal*. <https://www.wsj.com/articles/who-are-the-worlds-biggest-climate-polluters-satellites-sweep-for-culprits-11634635980>
- Repko, M. et al., “American Companies Spent Years in an Economic Boom. Then the Coronavirus Hit,” CNBC, May 10, 2020, <https://www.cnbc.com/2020/05/10/american-companies-spent-years-in-an-economic-boom-then-the-coronavirushit.html>
- Sarkis, J. (2020). Supply chain sustainability: Learning from the COVID-19 pandemic. *International Journal of Operations & Production Management*, 41(1), 63–73. <https://doi.org/10.1108/IJOPM-08-2020-0568>
- United Nations. (n.d.). *Transforming our world: The 2030 Agenda for Sustainable Development*. Retrieved October 31, 2021, from <https://documents-dds-ny.un.org/doc/UNDOC/GEN/N15/291/89/PDF/N1529189.pdf?OpenElement>
- Vallance, S., Perkins, H. C., & Dixon, J. E. (2011). What is social sustainability? A clarification of concepts. *Geoforum*, 42(3), 342–348. <https://doi.org/10.1016/j.geoforum.2011.01.002>
- Whitley E, Ball J. Statistics review 6: Nonparametric methods. *Crit Care*. 2002;6(6):509-513. doi:10.1186/cc1820
- World Commission on Environment and Development. (1987). *Our Common Future*. Oxford University Press.

Appendix A - Demographic Distribution of Respondents

Table A1

Number of Responses by Gender

Gender	# of Responses	% of Responses
Male	1148	74%
Female	410	26%
Total	1558	100%

Table A2

Number of Responses by Language

Language	# of Responses	% of Responses
English	1705	52%
Spanish	1456	44%
Simplified Chinese	123	4%
Total	3284	100%

Table A3

Number of Responses by Location

Location	# of Responses	% of Responses
Africa	73	5%
Asia	159	10%
Europe	249	16%

Latin America and Caribbean	711	44%
Mediterranean & Middle East	41	3%
North America	344	21%
Oceania	29	2%
Total	1606	100%

Table A4

Number of Responses by Age Range

Age Range	# of Responses	% of Responses
18-24	80	5%
25-34	435	27%
35-44	506	32%
45-54	339	21%
55-64	204	13%
65 or older	42	3%
Total	1606	100%

Table A5

Number of Responses by Industry

Location	# of Responses	% of Responses
Agriculture, Forestry, Fishing and Hunting	68	4%
Mining, Quarrying, and Oil and Gas Extraction	75	5%
Utilities	47	3%
Construction	91	5%
Manufacturing	297	18%

Wholesale	89	5%
Retail	96	6%
Transportation and Warehousing	244	15%
Health Care and Services	57	3%
Accommodation and Food Services	20	1%
Technology	104	6%
Business Consulting	89	5%
Academia	70	4%
Finance & Accounting	51	3%
Other	262	16%
Total	1660	100%

Appendix B – Demographic Response Test Results Isolated by Industry

Table B1

Significant Differences in Responses by Demographic Groupings Within a Single Industry

Demographic Grouping	Survey Question	Industry	Significance Value (reject the null hypothesis)
Gender	SCS Goals - Environmental	Manufacturing	>0.5 (not significant)
Gender	SCS Goals - Environmental	Transportation & Warehousing	0.037 (significant)
Gender	SCS Goals - Environmental	Retail	>0.5 (not significant)
Gender	SCS Goals - Social	Manufacturing	>0.5 (not significant)
Gender	SCS Goals - Social	Transportation &	>0.5 (not significant)

		Warehousing	
Gender	SCS Goals - Social	Retail	>0.5 (not significant)
Gender	SCS Investments - Environmental	Manufacturing	0.047 (significant)
Gender	SCS Investments - Environmental	Transportation & Warehousing	0.032 (significant)
Gender	SCS Investments - Environmental	Retail	>0.5 (not significant)
Gender	SCS Investments - Social	Manufacturing	>0.5 (not significant)
Gender	SCS Investments - Social	Transportation & Warehousing	>0.5 (not significant)
Gender	SCS Investments - Social	Retail	>0.5 (not significant)
Gender	COVID-19 Impact on SCS Commitment - Environmental	Manufacturing	0.021 (significant)
Gender	COVID-19 Impact on SCS Commitment - Environmental	Transportation & Warehousing	>0.5 (not significant)
Gender	COVID-19 Impact on SCS Commitment - Environmental	Retail	>0.5 (not significant)
Gender	COVID-19 Impact on SCS Commitment - Social	Manufacturing	>0.5 (not significant)
Gender	COVID-19 Impact on SCS Commitment - Social	Transportation & Warehousing	>0.5 (not significant)
Gender	COVID-19 Impact on SCS Commitment - Social	Retail	>0.5 (not significant)

Location	SCS Goals - Environmental	Manufacturing	>0.5 (not significant)
Location	SCS Goals - Environmental	Transportation & Warehousing	0.042 (significant)
Location	SCS Goals - Environmental	Retail	>0.5 (not significant)
Location	SCS Goals - Social	Manufacturing	0.049 (significant)
Location	SCS Goals - Social	Transportation & Warehousing	0.036 (significant)
Location	SCS Goals - Social	Retail	>0.5 (not significant)
Location	SCS Investments - Environmental	Manufacturing	>0.5 (not significant)
Location	SCS Investments - Environmental	Transportation & Warehousing	>0.5 (not significant)
Location	SCS Investments - Environmental	Retail	>0.5 (not significant)
Location	SCS Investments - Social	Manufacturing	0.032 (significant)
Location	SCS Investments - Social	Transportation & Warehousing	>0.5 (not significant)
Location	SCS Investments - Social	Retail	>0.5 (not significant)
Age Range	SCS Goals - Environmental	Manufacturing	>0.5 (not significant)
Age Range	SCS Goals - Environmental	Transportation & Warehousing	>0.5 (not significant)
Age Range	SCS Goals - Environmental	Retail	>0.5 (not significant)
Age Range	SCS Goals - Social	Manufacturing	>0.5 (not significant)
Age Range	SCS Goals - Social	Transportation & Warehousing	>0.5 (not significant)

Age Range	SCS Goals - Social	Retail	>0.5 (not significant)
Age Range	SCS Pressures - Internal	Manufacturing	>0.5 (not significant)
Age Range	SCS Pressures - Internal	Transportation & Warehousing	>0.5 (not significant)
Age Range	SCS Pressures - Internal	Retail	>0.5 (not significant)
Age Range	SCS Pressures - External	Manufacturing	>0.5 (not significant)
Age Range	SCS Pressures - External	Transportation & Warehousing	>0.5 (not significant)
Age Range	SCS Pressures - External	Retail	>0.5 (not significant)