STATE OF SUPPLY CHAIN
SUSTAINABILITY 2021

MIT | **MIT** Center for Transportation & Logistics

CSCMP Council of Supply Chain Management Professionals

Suggested citation:

Bateman, Alexis, Kellen Betts, Ken Cottrill, Jason Pang, and Aniruddha Suhas Deshpande; Ken Cottrill, Arthur Grau, and Daniel McCool, eds. "State of Supply Chain Sustainability 2021." Cambridge, Mass.: MIT Center for Transportation & Logistics and Council of Supply Chain Management Professionals, 2021.

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The MIT Center for Transportation & Logistics (MIT CTL) is a leading research and educational center within the Massachusetts Institute of Technology with almost 50 years of supply chain expertise. In 2007, supply chain sustainability emerged as a key research area at the center. The center has responded with research, education, and outreach to address the continuing growth of supply chain sustainability as a business imperative fueled by the demands and requirements of consumers, governments, and investors. Supply chain sustainability research at the center is focused on enabling research and collaboration on the social and environmental sustainability of supply chain business processes.

About the Council of Supply Chain Management Professionals | cscmp.org

Since 1963, the Council of Supply Chain Management Professionals (CSCMP) has been the leading worldwide professional association dedicated to education, research, and the advancement of the supply chain management profession. With more than 9,000 members globally, representing business, government, and academia from 62 countries, CSCMP members are the leading practitioners and authorities in the fields of logistics and supply chain management.

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EXECUTIVE SUMMARY

Key Insights: The Path to 2021

Highlights from the second annual State of Supply Chain Sustainability Report include:

Last year, when the impact of the Covid-19 pandemic was still escalating, we expected the crisis to dampen companies' enthusiasm for investing in supply chain sustainability (SCS). Enterprises would surely divert their attention to combating the pandemic. Remarkably, the survey results suggest that Covid-19 did not significantly slow the push to make supply chains more sustainable. More than 80% of survey respondents in this year's report claimed the crisis had no impact or increased their firm's commitments to SCS. Executives were undeterred by the crisis; 83% of the executives interviewed said that Covid-19 has either accelerated SCS activity or, at the very least, increased awareness and brought urgency to this growing field.

A caveat to the steady progress in SCS between 2019 and 2020 is that the momentum appears to come primarily from large (1,000–10,000 employees) and very large (10,000+ employees) companies. Small- and medium-sized companies were more likely to pull back, with more enterprises in this category indicating they were not engaged before the pandemic and even less so during the crisis likely due to strained financial resources.

Still, the number and range of stakeholders that are compelling companies to pursue SCS has not diminished. A finding in line with last year's report is that the pressure to support sustainability in supply chains is coming from multiple sources, both internal and external. Between 2019 and 2020, pressure from investors, government, and international bodies grew the most of all sources (see **Figure 8**).

Internally, company executives emerged as critical SCS champions. Executives were the most significant source of pressure behind corporate commitments to supply chain sustainability across all issue areas. Given executives' central role in setting and steering strategies for growth, this finding suggests that the drive toward supply chain sustainability is not a fad but rather a business trend to watch.

Companies' overall commitment to social and environmental issues were similar between 2019 and 2020. However, interest in some areas such as human rights protection, worker welfare and safety, and energy savings and renewable energy, increased significantly. The growing interest in social and labor issues is a continuation of a trend we saw in the first report. In 2020, this finding is likely due to, in large part, the reprioritization of corporate goals during the pandemic.

This year's report sheds light on how companies put their SCS promises into practice. Of the many ways to accomplish this, three common approaches emerged, including supplier development, supply chain visibility, and environmental impact reduction. Supplier development was the most common across all industries; however, visibility proved equally attractive in manufacturing and transportation.

As the supply chain sustainability field advances, so does this report, and this year we introduce a classification of companies based on behaviors related to SCS. The model, called the SCS Firm Typology, yields fresh insights into the state of sustainability in supply chains. Categories of firms range from low-effort enterprises with little engagement in SCS to highly committed leaders. This typology distills the report's analyses into an interpretable model and enables future exploration of the evolution of SCS across multiple dimensions.

An indication of the typology tool's potential is this year's analysis of supply chain professionals' engagement in SCS activities—a critical determinant of what companies can accomplish in this area. The level of engagement shown by practitioners (from operating as a decision maker to having no engagement at all) was aligned with the commitment shown by different categories of firms. For example, professionals in firms that we identified as "Leaders" exhibited the highest level of engagement.

Proposed Outlook: The Future of Sustainable Supply Chains

In the concluding section, the authors offer a point of view on the potential evolution of supply chain sustainability over the next five years. Highlights include:

With the increased momentum for major commitments to supply chain sustainability in 2020, the future will likely bring greater investments in sustainability—and scrutiny of the degree to which enterprises deliver on their promises.

With more scrutiny comes more responsibility. If the pressure from investors and regulators does indeed put companies' supply chain sustainability practices under a microscope, this will in turn require more enterprises to increase transparency and disclosure of practices and activities in their supply chains.

As the pressure to pursue SCS increases, so too will the importance of supply chain professionals as sustainability champions and practitioners. To support and help drive progress, more supply chain professionals will be engaged in sustainability efforts and help companies to overcome the many formidable barriers to SCS that lie ahead. These impediments differ from company to company and from one industry to another, but our research identified some common threads, such as the key role of suppliers in furthering supply chain sustainability.

Investors are wielding more influence as advocates of SCS, and we expect this to continue in the near term. The connection between companies' track records in sustainability and their ability to win market share and turn a profit is likely to strengthen.

Social issues and climate change mitigation will likely feature prominently in the future of SCS. Both areas received much attention in 2020, and both pose long-term challenges that are unlikely to abate in the foreseeable future.

We're already looking forward to the 2022 edition.

THE REPORT

The State of Supply Chain Sustainability

THE *STATE OF SUPPLY CHAIN SUSTAINABILITY* OFFERS A COMPREHENSIVE EXAMINATION OF supply chain sustainability across industries, geographies, functions, and roles, giving professionals and executives a holistic view of sustainability in the supply chain domain. The MIT Center for Transportation & Logistics (MIT CTL) and the Council of Supply Chain Management Professionals (CSCMP) published the first annual edition in 2020.* The first report established a baseline for subsequent research. Our goal in undertaking this research is to explore how supply chain sustainability is being implemented in global supply chains, to identify broad trends across industries and regions, and illustrate what that means for companies and professionals.

Our research for the inaugural report included a broad survey of industry professionals and in-depth interviews with executives. We found that commitment to supply chain sustainability is a focus for many large (1,000–10,000 employees) and very large (10,000+) companies. We also observed that the tangible investments companies make in supply chain sustainability do not always match their ambitions, especially concerning human rights protection, worker welfare and safety, and fair pay/fair trade. However, companies facing pressure from multiple sources often invest more in these areas of sustainability than those that are not incentivized by pressure from stakeholders.

These early insights provided a snapshot of the state of supply chain sustainability at a macro level. They also left many questions unanswered. Are there underlying patterns in how companies act? How do supply chain sustainability goals, investments, practices, and other measures change over time? What is the impact of the Covid-19 pandemic?

We attempt to answer some of these questions in the current report by refining our analysis and building off the foundation established with last year's report.

The current report has four dimensions: First, we establish a framework for examining supply chain sustainability in 2020 based on the same measures of pressure, commitment, investment, practices, disclosure, and engagement established last year. Next, we explore the effect of the Covid-19 pandemic on supply chain sustainability and changes between 2019 and 2020 to understand how these measures change over time. We then develop a quantitative typology of firms based on their level of commitment to supply chain sustainability. Finally, we conclude with an outlook on what is to come for supply chain sustainability.

Building off of last year's report, our second survey included input from twice as many supply chain professionals. We also conducted a new round of executive interviews with a wide range of professionals and companies to explore supply chain sustainability trends more deeply. Finally, we refreshed and extended our analysis of reports, press releases, media articles, and other documents to track activity in the public sphere.

The report provides a platform to observe how supply chain sustainability changes over time and how supply chain professionals react to these changes. It does not take a stance on whether industries are doing enough (or too much) or on what they should (or shouldn't) do; it is simply a gauge of the direction of supply chain sustainability.

Through this journey, we have developed a more nuanced understanding of supply chain sustainability, and we believe the report's findings will help professionals make better strategic decisions and companies achieve sustainability goals in their supply chains.

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*   *The State of Supply Chain Sustainability was launched in 2020 but was based on data collected in 2019; likewise, the 2021 report consists of data collected in 2020.*

Defining Supply Chain Sustainability in 2020

THE EVENTS OF 2020 BROUGHT WIDESPREAD ATTENTION TO THE SOCIAL and environmental impact of global supply chains. However, the term supply chain sustainability (SCS) is still not well understood. News coverage of the topic has been wide in scope with varying interpretations. **Figure 1** demonstrates this by summarizing the key words found in the top 200 news stories from 2020 that discussed SCS. What jumps out immediately are words such as "new", "more", "global", "demand", and "environmental". These words signal interesting trends in the public discourse around this topic. It also shows that SCS interfaces with many complex and overlapping concepts.

In this report, our definition of SCS has not changed from the first *State of Supply Chain Sustainability*[1] and is based on both the environmental and social concerns of sustainability. We define supply chain sustainability as the management of environmental and social impacts within and across networks consisting of suppliers, manufacturers, distributors, and customers in line with the UN Sustainable Development Goals. This spans every phase of the supply chain, from raw material sourcing and extraction to product use and end of product life.

Treemap of word frequencies in news search

Count: 195 ▮▮▮ 35
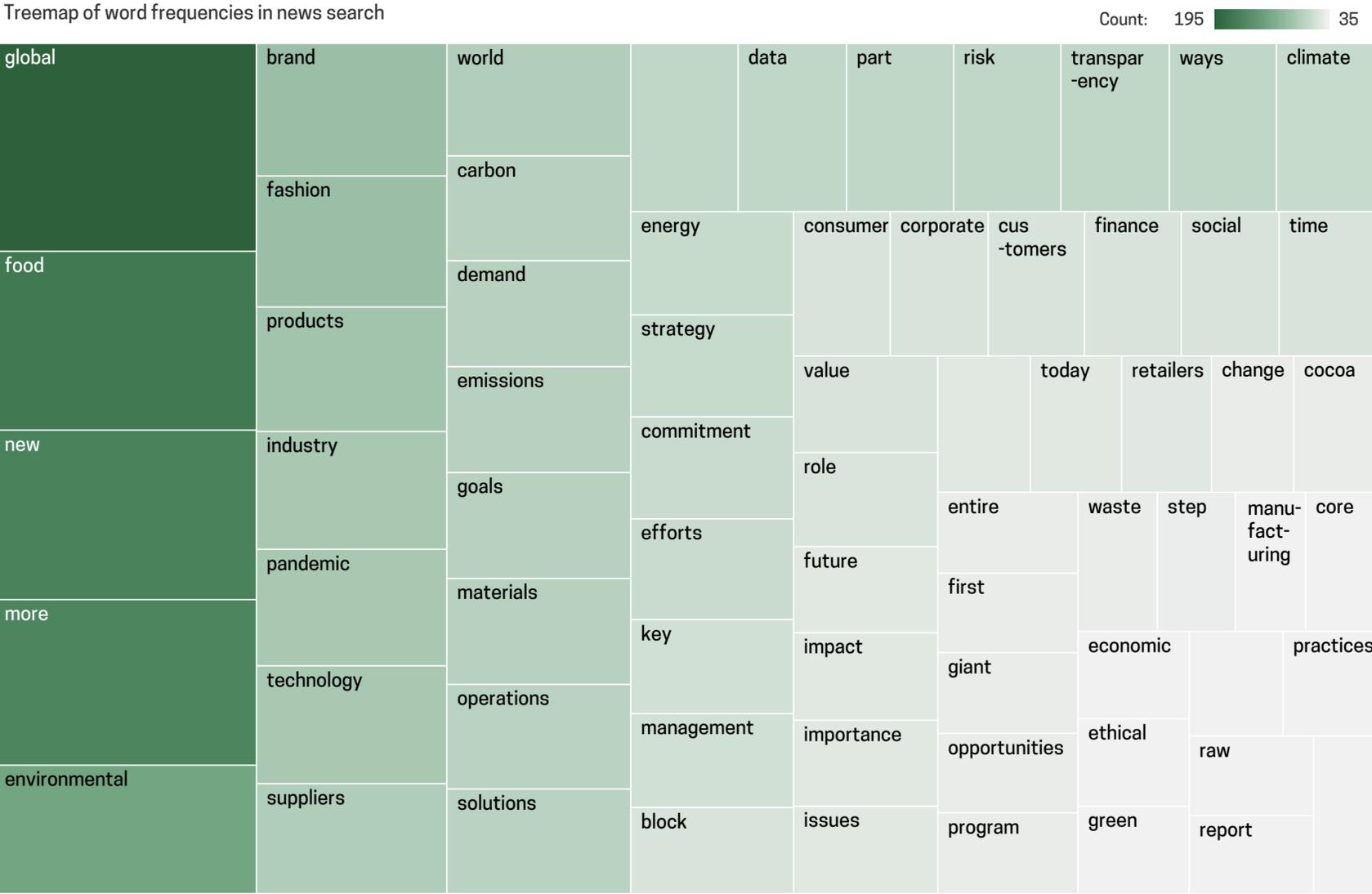
Figure 1: *A treemap diagram illustrating the frequency of words found in the top 400 articles extracted from Google News when searching "supply chain sustainability" in 2020. N = 400 articles.*

Research Approach

Our three-tiered research effort comprises a large-scale survey of supply chain professionals, executive interviews, and an analysis of relevant news items, social media content, and reports. The triangulation of these three sources allows for a more comprehensive and systematic view of the state of SCS. See **Appendix A** for more details about our research methods.

The number of survey responses we received this year was more than double the number received in 2019. The majority of responses came from North America and Europe (see **Figure 2**), with a greater share from Europe in 2020 compared to the previous year. As shown in **Figure 3,** the majority of responses came from men, skewed toward younger professionals working in a supply chain department. We also received responses from different industries including manufacturing, transportation and warehousing, business consulting, retail and others. The age, gender, industry, and company department/function profile were similar to the 2019 report.

North America 38%

Europe 25%

Mediterranean & Middle East 4%

Asia 16%

Africa 5%

South America 11%

Oceania 1%
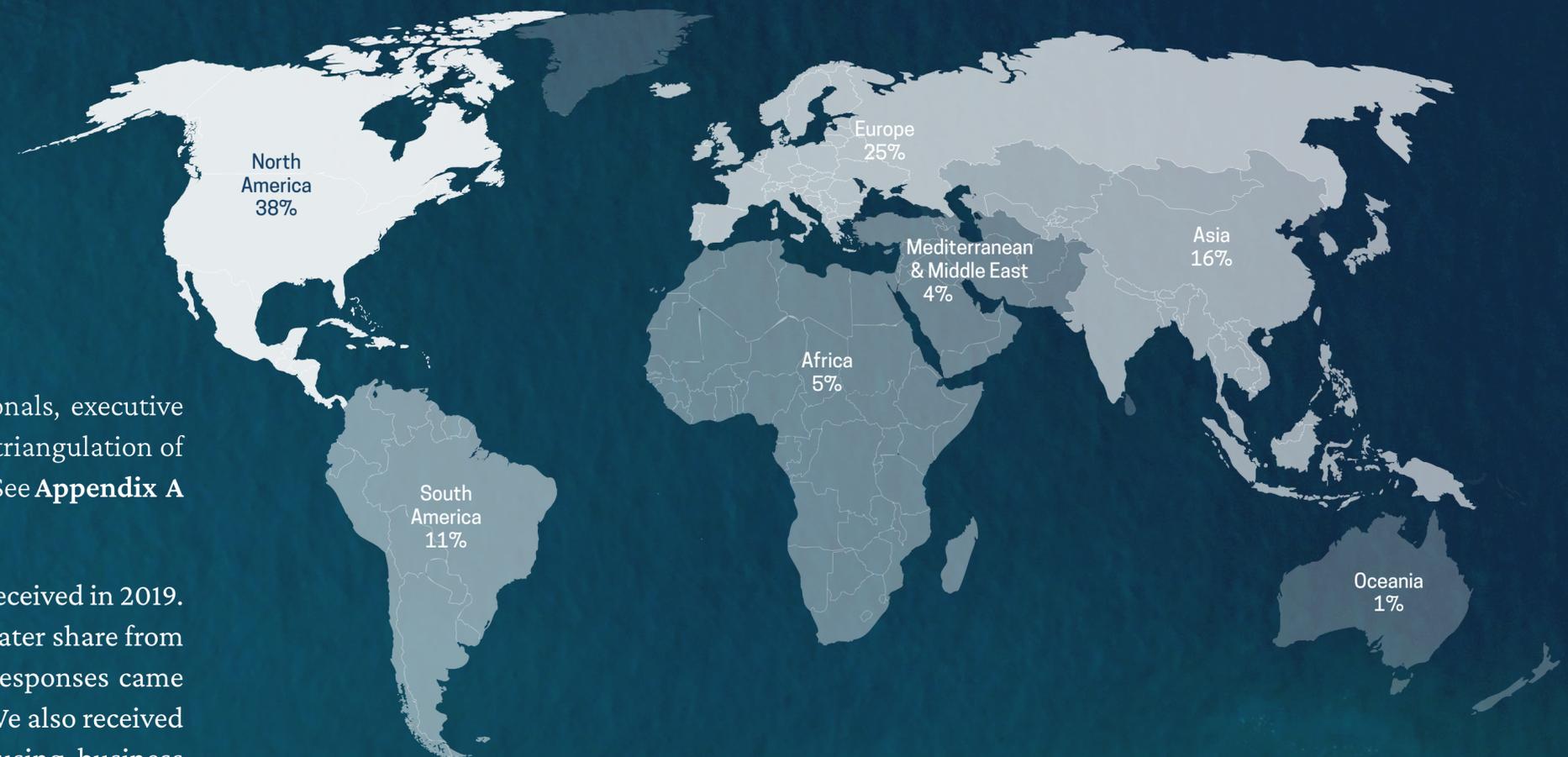
2,400 Survey respondents*

21 Executive interviews

250+ Documents reviewed

Respondent age

Percent of total (18-24, 25-34, 35-44, 45-54, 55-64, 64+; 0%–40%)

Respondent gender

Male	Female
1,122	387

Respondent business function

Percent of total (0%–35%): Supply chain, Logistics, Procurement, Production & manufacturing, Planning, Sales, Design & product development, Warehousing & inventory, Sustainability, Marketing

Respondent industry

Percent of total (0%–25%): Other, Manufacturing, Transportation & warehousing, Businesss consulting, Retail, Healthcare & services, Mining, quarrying & oil and gas extraction, Agriculture, forestry & fishing and hunting, Wholesale, Construction

Figure 2 (top): Breakdown of respondents by geographic region. N = 1,492.

Figure 3 (bottom left and right): respondent age and gender (second from left); business function (middle); and industry (lower right). N = 1,537.

*A subset of this total number of survey responses was used for analysis based on how much of the survey they completed. See **Appendix A** for more details on how the survey responses were analyzed and the limitations of survey data.

A Year of Disruption

THE YEAR 2020 BEGAN WITH GROWING AWARENESS OF AND INTEREST IN SUSTAINABILITY issues. In the prior year, sales for products with sustainability-related labels grew seven times faster than previously recorded levels,[2] and the amount of engagement on social media around climate change issues had tripled.[3] Companies increasingly used sustainability as a marketing strategy, and multinationals touted a commitment to sustainability with more intense efforts to measure and monitor impacts across the supply chain.[4]

In the first few weeks of 2020, many high-profile companies unveiled ambitious sustainability goals and investments.[5] However, by February, Covid-19 had put a stranglehold on the world's economy.[6] The impacts on companies and supply chain professionals were swift and extreme. Some businesses were overwhelmed with demand for their products due to shifts in consumer behavior associated with public heath lockdowns and the urgent need to provide essential services. Other businesses shut down as demand plummeted and the risk of infection spiked. Many of these businesses closed permanently.[7]

While the pandemic dominated headlines, other events drew attention to supply chain sustainability. Examples include clear-cutting of the Amazon rainforest for grazing cattle in Brazil[8] and increasing volumes of waste from discarded single-use personal protective equipment (PPE).[9] Social issues also gained prominence, such as the vulnerability and poor treatment of front-line supply chain workers[10] and the fallout from the mistreatment of Uyghurs in the Xinjiang region of China.[11] Our research indicates that these occurred while firms continued or increased their commitments to and investments and practices in supply chain sustainability. Corporations also became eager to show their commitment to different stakeholders' concerns with actions such as pledges to achieve net-zero greenhouse gas emissions; promoting workplace diversity, equity, and inclusion; and instituting front-line worker protections.

Timeline of Critical Events

Deforestation and palm oil

Brazil's National Institute for Space Research reported that the rate of deforestation in the Amazon in 2019 was at the highest level in over a decade. Reports by the World Wildlife Fund and the Rainforest Action Network found that some of the world's biggest consumer brands were failing to meet their commitment to eliminate deforestation in their supply chains by sourcing sustainable palm oil by 2020.[12]

Plastic ban in China

The Chinese government announced efforts to crack down on plastic pollution in the country's manufacturing economy. China accounts for close to 30% of global plastic products, and the government plans to phase out all single-use plastic usage by 2025. This domestic regulation of plastic consumption comes after China's decision to stop accepting plastic waste from other countries for recycling due to environmental concerns.[13]

January

Coronavirus spreads

After the initial outbreak of a novel coronavirus strain in Wuhan, China, cases spread throughout Asia, Europe, and the US. Despite significant efforts to contain the spread of the virus, including a travel ban to and from eight cities in Hubei Province, more than 65 countries reported new cases, including India, Italy, Iran, Japan, New Zealand, and South Korea.

February

Human rights concerns in supply chains linked to Xinjiang

The Australian Strategic Policy Institute (ASPI) released a new report on forced labor in Xinjiang, China, which revealed that more than 80,000 Uyghur and other ethnic-minority citizens from Xinjiang were transferred to factories across China between 2017 and 2019 under conditions that strongly suggest forced labor. These factories, along with other programs in Xinjiang accused of abusing human rights, have been tied to the supply chains of many well-known global brands.[14]

March

Pandemic and lockdowns

Coronavirus-related lockdowns were imposed in parts of major western countries. The impact was felt immediately across all major industrial and retail supply chains. The US declared coronavirus a national emergency, and all 50 states in the US mandated statewide shutdowns of nonessential businesses. On March 11, the World Health Organization declared Covid-19 a pandemic.[15]

April

Impact of the pandemic on procurement and logistics

The pandemic's impact on industries sourcing predominantly in China exposed a lack of diversification in their supplier base. Third-party logistics companies observed a sharp drop in import volumes across the manufacturing, automotive, and healthcare industries. Disruption in Chinese manufacturing, exports, and port activities resulted in a severe cargo backlog. According to reports by DHL, container volume handled at Chinese ports decreased by more than 10%. The trucking industry in the US faced similar constraints as capacity was severely reduced due to additional demand allocated to medical and food supply transportation. The volume of air freight carried on passenger flights fell by roughly 20%. The overall demand-capacity mismatch resulted in significantly higher air freight rates. More than 60% of air capacity between China and Europe was reduced by the end of March.[16]

Carbon emissions drop during pandemic

Global carbon emissions fell 8% in the first four months of 2020. The aviation industry experienced one of the most dramatic declines, with emissions falling by more than 21% in the first four months of the year. The largest absolute emission reductions were in the electric power and ground transport sectors.[17]

May

What companies are doing to fight systemic racism

The murder of George Floyd on May 25, 2020, by a Minnesota police officer sparked global outrage and a global movement bringing attention to systemic racism and inequality in policing, workplaces, and other areas of society. Many companies made substantial commitments to tackling inequality in their own workplaces, donating to social justice organizations, and using their platforms to promote racial diversity, equity, and inclusion in the business community.[18]

Supply chain agility

Companies shifted focus to supply chain agility instead of accurate forecasting. At Unilever, demand for essential products such as cleaning supplies increased by up to 600%. In response, the company converted production lines and reduced the total number of SKUs it produced by 65%.[19]

June

July

Medical supply chains in focus with Defense Production Act

Camera maker Kodak was enlisted to assist the US government in manufacturing vaccines and drugs for Covid-19 by virtue of the company's experience manufacturing chemicals under the US Defense Production Act with an expected loan of $765 million. This news came after Fujifilm Diosynth Biotechnologies, a joint venture between Japan's Fujifilm and Mitsubishi, was tapped to support coronavirus vaccine manufacturing through a $265 million contract between the US Biomedical Advanced Research and Development Authority and Texas A&M University.[20]

Women CSCOs

A 2020 survey conducted by Gartner found that 17% of chief supply chain officers were women, an increase of 6% from 2019. However, the total number of women in the field overall remained stagnant at less than 40%, an increase of only 5% from 2016. Consumer goods and retail industries saw women in 25% of CSCO roles, whereas only 13% were in industrial companies.[21]

August

California wildfires

California experienced record-breaking wildfires, creating hazardous environments for workers and disrupting supply chain and logistics operations in places like warehouses, retail stores, manufacturing plans. It also forced the closure of essential road links, such as Pacific Coast Highway, and power outages occurred in many areas. By early September, a combination of a record-breaking heat wave and Diablo and Santa Ana winds sparked the largest wildfire on record in California.[22]

September

Women leave the workforce at high rates

In the US, women left the workforce at four times the rate that men did during the month of September. The trend was attributed to a lack of childcare options and other economic disruptions that have had a disproportionate impact on women. An analysis of Indeed job postings across 22 countries showed a significant gender gap in job offerings as well. Postings for jobs with low female representation fell 37% and ended the year down 18%. Postings for jobs with high female representation, in contrast, fell almost 43% and ended the year down 25%. There was a similar gap based on skill level, with low-skilled postings dropping almost 45% at the height of the pandemic, compared to a 35% drop for higher-skilled jobs.[23]

The lithium "gold rush"

In California, a new state government initiative was established in September to explore how best to develop lithium deposits in the deserts east of Los Angeles and San Diego. According to the California Energy Commission, the Salton Sea, a shallow lake in California's Imperial County, could supply 40% of global lithium demand.[24]

October

Supply chain workers serve on the front lines and risk exposure to Covid-19

Warehouse, transportation, and other supply chain workers worked tirelessly on the front lines of the pandemic to ensure that medical supplies and consumer goods were available as needed. Nearly 20,000 Amazon workers tested positive for Covid-19 during this timeframe.[25]

Seafarers stranded at sea

Over 300,000 seafarers—20% of the global workforce—were stranded at sea waiting for relief from extended deployments. Meanwhile, shipping companies, labor unions, and maritime authorities navigated a patchwork of pandemic-related crew restrictions and significant disruptions to global trade flows.[26]

Coronavirus vaccines

After a remarkable effort by biotechnology and pharmaceutical companies to develop and start production of Covid-19 vaccines, the spotlight shifted to the challenges of distribution, including the need to build a cold supply chain for temperature-sensitive vaccines.[27]

Port congestion

West Coast ports in the US faced a severe container backlog, impacting supply chains across the US, Canada, and Mexico. The backlog was caused, in part, by an increase in imports (especially ahead of the holiday season) and challenges associated with the handling of ships in port. The backlog contributed to a global imbalance of container availability, led to sharp increases in ocean freight rates (with massive surcharges), and led to third-party logistics companies pushing for the use of 20-foot containers instead of 40-foot containers.[28]

November

December

Brexit

The last week of the year brought a new political and economic landscape in Europe with the UK officially leaving the European Union after a 2016 referendum. A last-minute trade deal announced on Christmas Eve brought some relief to British companies faced with the monumental task of learning how to navigate complex new trade rules. Regulators gave companies a few months to grasp the new rules before they need to start submitting UK customs declarations and EU rules-of-origin paperwork.[29]

Positive train control in the US

On December 29, the Federal Railroad Commission (FRA) announced that positive train control (PTC) technology was successfully deployed on all 57,536 miles of required track (40% of the nation's Class I rails).[30] PTC technology tracks a train's position and automatically deploys braking to prevent collisions, speeding, and trains entering danger zones.

Covid-19's Unexpected Effect

In the 2020 report, some supply chain executives suggested there may be a setback or "pause" in commitments to and investments in supply chain sustainability until businesses recovered from the disruption caused by the Covid-19 pandemic. Many supply chain experts expected businesses to focus on "core" objectives of getting product to customers and managing cash flow.

Based on publicly available evidence, some industries negatively impacted by the pandemic, such as travel and hospitality,[31] scaled back their sustainability efforts. However, our research shows that many large companies in a variety of industries announced new, bold goals on climate change mitigation; employee health and safety; fair pay; diversity, equity, and inclusion; and other issues despite the severe impacts of 2020.

In fact, some executives said that the pandemic had a limited impact on SCS and may have propelled or "accelerated" their sustainability efforts. The pandemic, social justice movement, and other events of 2020 particularly increased awareness of certain social aspects of SCS including worker welfare and safety, fair pay, and social justice issues.

Kyra Whitten, Vice President of Corporate Marketing, Communications, and Sustainability for electronics manufacturer Flex, said that SCS has gained momentum since the start of the pandemic: "We've reached somewhat of a tipping point with sustainability amplifying the momentum that [it's] not going to stop. We see the increased requirements from customers, from employees, from governments to act sustainably. This focus had really taken hold, and then Covid accelerated it."

> "I think not just because of Covid-19, but because of the combination of Covid-19 and other social challenges, there's actually an increased awareness. Firms need to care about people in a way that's a little bit different, whether it's employees or communities. I think it's actually been a very positive shift in a way."
> —**Adam Schafer,** *Director of Supply Chain Sustainability, Intel Corporation*

> "Earlier on in the pandemic, there [were] definitely quite a few skeptics around. But, if anything, you've seen an acceleration in corporate efforts and a huge increase, I think, in disclosure and transparency because we're being asked. That's why we issued our inaugural ESG report—and not just us; everyone is."
> —**Ezgi Bercenas,** *Global Vice President, Head of Sustainability, Anheuser-Busch InBev*

In the survey, approximately 80% of respondents said their firm's commitment to SCS had either increased or stayed the same since the start of Covid-19, while 9% said it had decreased, and another 9% said they weren't sure (see **Figure 4**). A similar number said that the pressure on their firm to increase the sustainability of their supply chain stayed the same or increased since the pandemic's start, and only 6% said that pressure had decreased.

Since the start of Covid-19, my firm's commitment to supply chain sustainability has…

- Not sure 9%
- Decreased 9%
- Increased 36%
- Same 46%
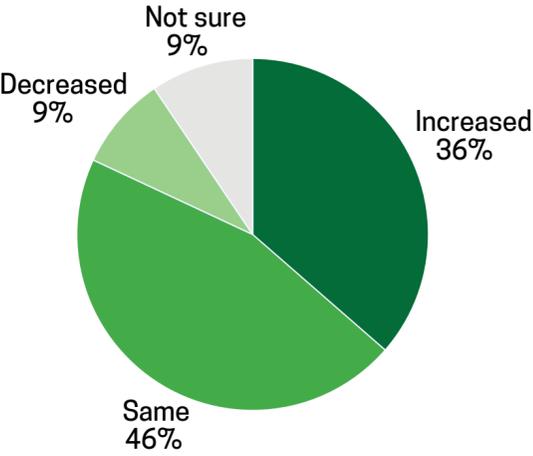
Figure 4: Breakdown of respondents by how their firm's commitment to SCS has changed since the start of the pandemic. N = 1,557.

Firms in North America and Europe were more likely to have experienced similar levels of pressure for SCS in 2020 compared to before the pandemic. The greatest increases were seen in the Middle East, Mediterranean, and Asia, with over 40% of respondents in these regions saying pressure has increased since the start of the pandemic (**Figure 5**). This is likely due to growing customer awareness[32] and increasing regulatory requirements in both regions.[33]

Has pressure on your firm for supply chain sustainability changed during Covid-19?
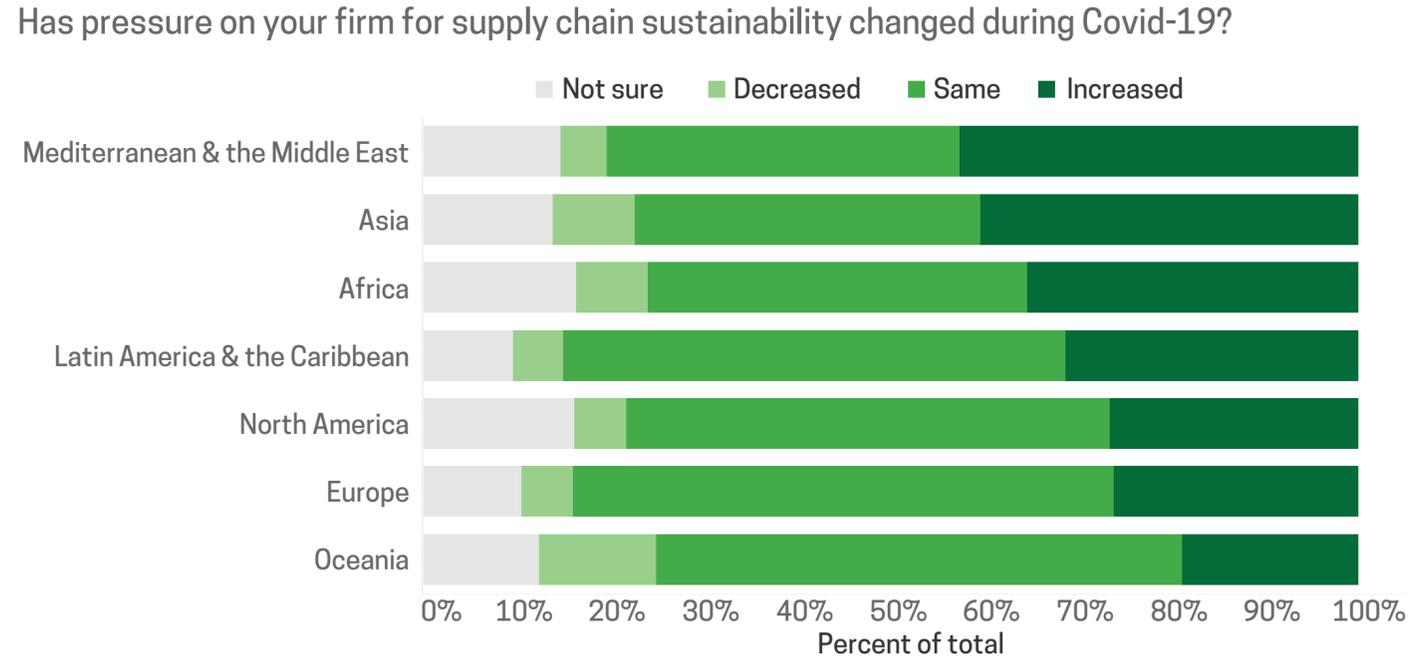
Figure 5: Supply chain sustainability pressure amid Covid-19 by region. N = 1,555.

Radu Palamariu, Managing Director for Asia Pacific at supply chain recruitment agency Alcott Global, echoes this trend in Asia: "The shift that has already happened since 2019 and is now accelerating, in that the general public, the stock market, and the investors are demanding that sustainability be [at the] top of the agenda. Hence, especially MNCs have continued to invest and develop the directions around it, even if maybe less intensely than if Covid-19 had not happened."

As shown in **Figure 6**, the majority of companies of any size either increased or maintained their commitment to SCS. Eighty-seven percent of respondents from very large companies with 10,000+ employees did so, but so did 76% of the smallest companies with fewer than 100 employees.

How has your firm's commitment to SCS increased since the start of Covid-19?
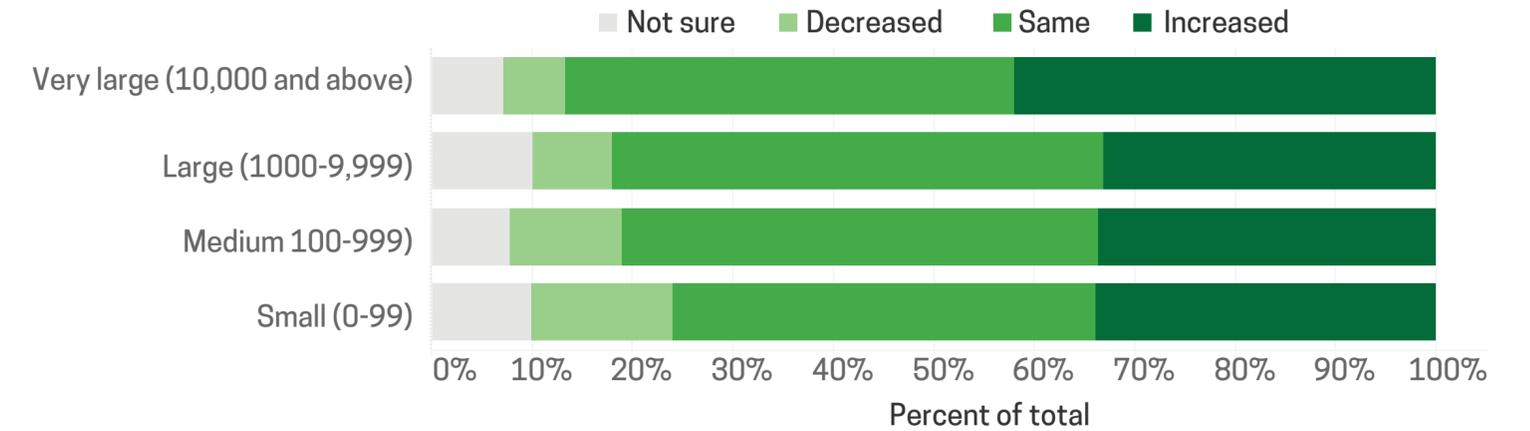
Figure 6: SCS firm commitment amid Covid-19 by company size. N = 1,550.

For the small percentage of companies that did scale back on their commitments, small companies represented the largest share: 14% decreased their commitment, compared to 6% of very large companies. This suggests that larger companies where able to withstand the disruptions of 2020 and maintain their commitment to SCS compared to smaller companies.

Of the industries represented in the sample, three saw the most significant increase in commitment to SCS since the start of the pandemic. Between 41% and 53% of survey respondents in construction, retail, and healthcare reported an increase in commitment to SCS. While statistical tests did not show significant differences between industries due to Covid-19, these industries showed increasing SCS activity and faced more scrutiny of sustainability-related actions.

Pressure for Supply Chain Sustainability Continues

While Covid-19 turned the attention of the world to a global public health crisis, the pressure on firms during the 2019–20 period to become more sustainable did not abate. As seen in **Figure 7**, in both 2019 and 2020, approximately 47% of respondents reported that their firms received pressure to increase SCS. However, fewer respondents said their company felt no pressure between the two years.

Is your company under pressure to be more sustainable?
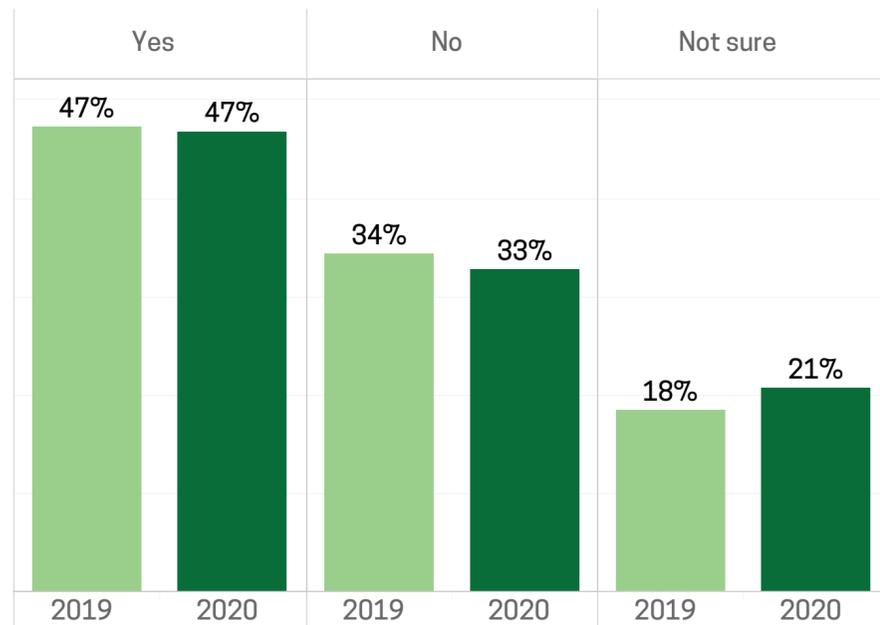
Figure 7: Year-over-year change in respondents reporting whether their firm felt pressure to act on SCS; totals may not sum to 100% due to rounding. N = 2,171.

The pressure on firms to support SCS initiatives may be due in part to the continued influence of events in 2019, such as wildfires in the US that thrust climate change into the spotlight.[34] Public concern about the social and environmental impacts of supply chains was amplified further by developments in 2020, such as the need to adapt to shifting product shortages and redefining supply chain front-line workers as essential workers.

The pressure on firms to adopt SCS practices came from various sources, including governmental and international bodies, mass media, local communities, and NGOs, external corporate buyers, employees, and company executives. While there was an increase in pressure exerted among almost all groups, the largest year-over-year rise in pressure came from investors, governments, and international governing bodies (see **Figure 8**).

> "Interest from our shipper customers has increased drastically, even in the past 6–18 months. In 2020, our customer survey revealed that sustainability issues were the second-highest concern after capacity. At the core of achieving sustainability is the ability to solve some of supply chains' toughest issues."
> **—Rachel Schwalbach,** *Vice President of ESG, C.H. Robinson*

How would you rate the level of pressure the following parties place on your firm to increase supply chain sustainability?

1 = No pressure ... 5 = Intense pressure
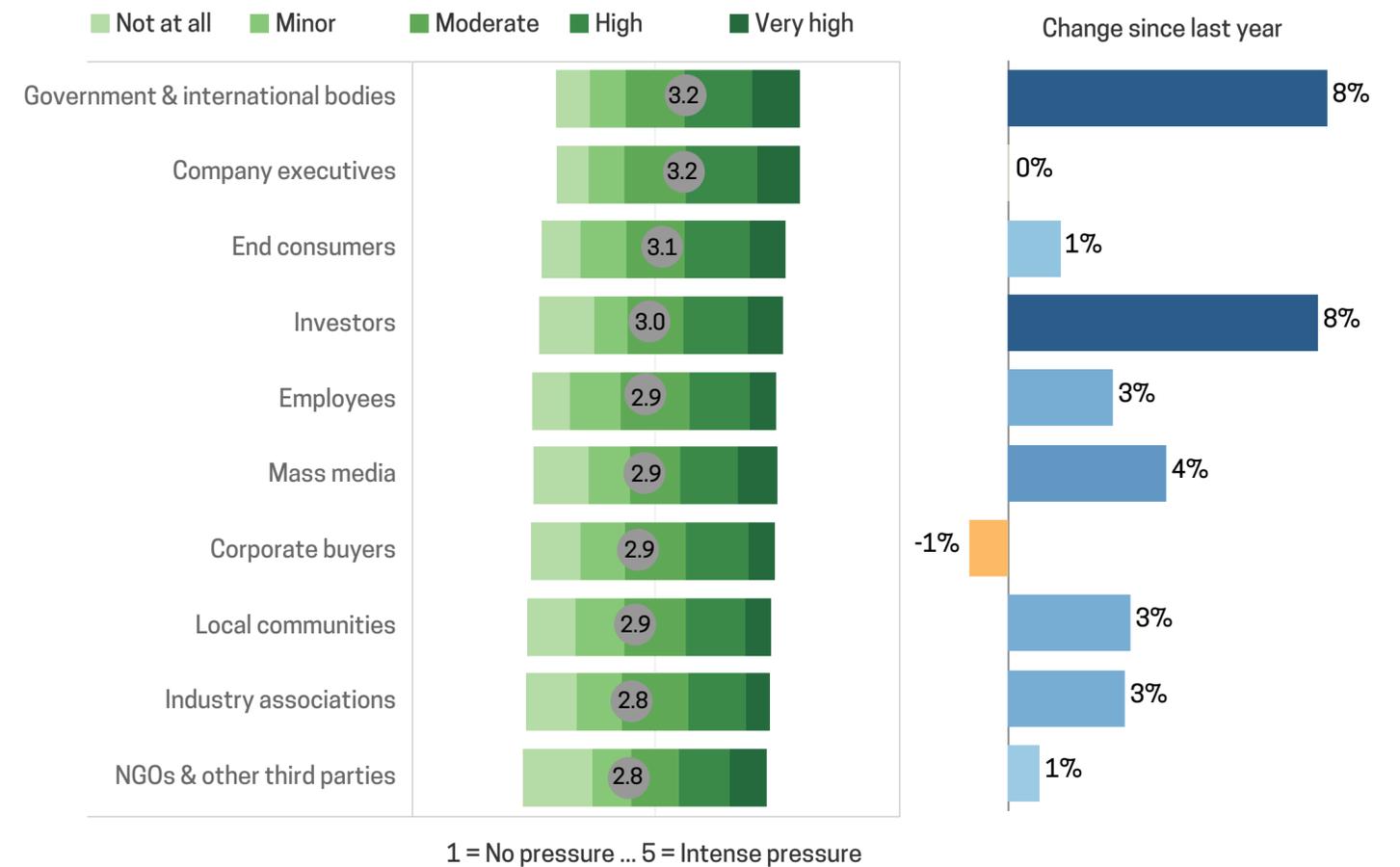
Figure 8: Range and average intensity of reported pressure by source and the change from last year. A statistically significant increase (t-test, $p < 0.05$) was seen from investors and government bodies both at 8% year over year. N = 284 (2019) & 722 (2020).

The pressure from investors reflects the growth in sustainability-related investment opportunities. These include environmental, social, and governance (ESG) investing and risk-based opportunities where investors evaluate companies' vulnerability to climate-related impacts and how much enterprises are investing in efforts to reduce their environmental impact and improve social conditions. Even though the focus during the pandemic shifted to survival and resilience, ESG still outperformed other investment categories.

Similarly, new regulations such as the European Green Deal[35] and the proposed US Slave-Free Business Certification Act of 2020[36] are a testament to the increasing influence government will have on social and environmental compliance in the supply chain.

The executives we interviewed had a slightly different take on the sources of SCS-linked pressures their companies were experiencing. Half of executives said that customers were the main driver for change, while only 20% said that governments, investors, and NGOs were a source of pressure on their companies. The reason for this finding might be that executives view SCS through a customer-centric lens; while they are aware of the many sources of pressure, they are especially sensitive to feedback from consumers and buyers.

> "We had quite a lot of 'internal pressure' already, as we had ambitious 2020 targets set already in 2009–10. Today, the pressure is both internal and external. This is creating a lot of momentum to innovate in this area."
> —**Sergio Barbarino,** *Research Fellow in Sustainability, Procter & Gamble*

On an industry level, most executives reported consistent pressure from multiple sources to pursue SCS initiatives. According to CSCMP Interim President and CEO Mark Baxa, "Companies are experiencing increased pressure to pursue sustainable business practices. There are companies receiving pressure from stakeholders, investors, boards, and employees. Furthermore, companies are being asked more questions in this space with greater expectations that companies make a positive impact in supply chain sustainability."

A key question is which sources of pressure drive commitments to SCS. Using logistic regression analysis, we found that pressure from executives is most strongly correlated with SCS commitments, suggesting that when executives champion the cause, companies commit to improving SCS performance. As can be seen in **Table 1**, the results were statistically significant for each commitment area, from climate change mitigation to human rights protection.

The other sources of pressure, including industry associations and local communities, were not correlated. This discrepancy suggests that without executive ownership of SCS, a firm may be less likely to take action. To make progress on SCS, firms must bake it into the core duties of leadership roles.

Less clear is what are the most influential pressures on executives to take on an SCS mantle. This is an open question that will be explored in a future report.

Table 1: Pressure sources with statistically significant regression coefficients for goal setting. see Table 7 for full results. N = 1,557.

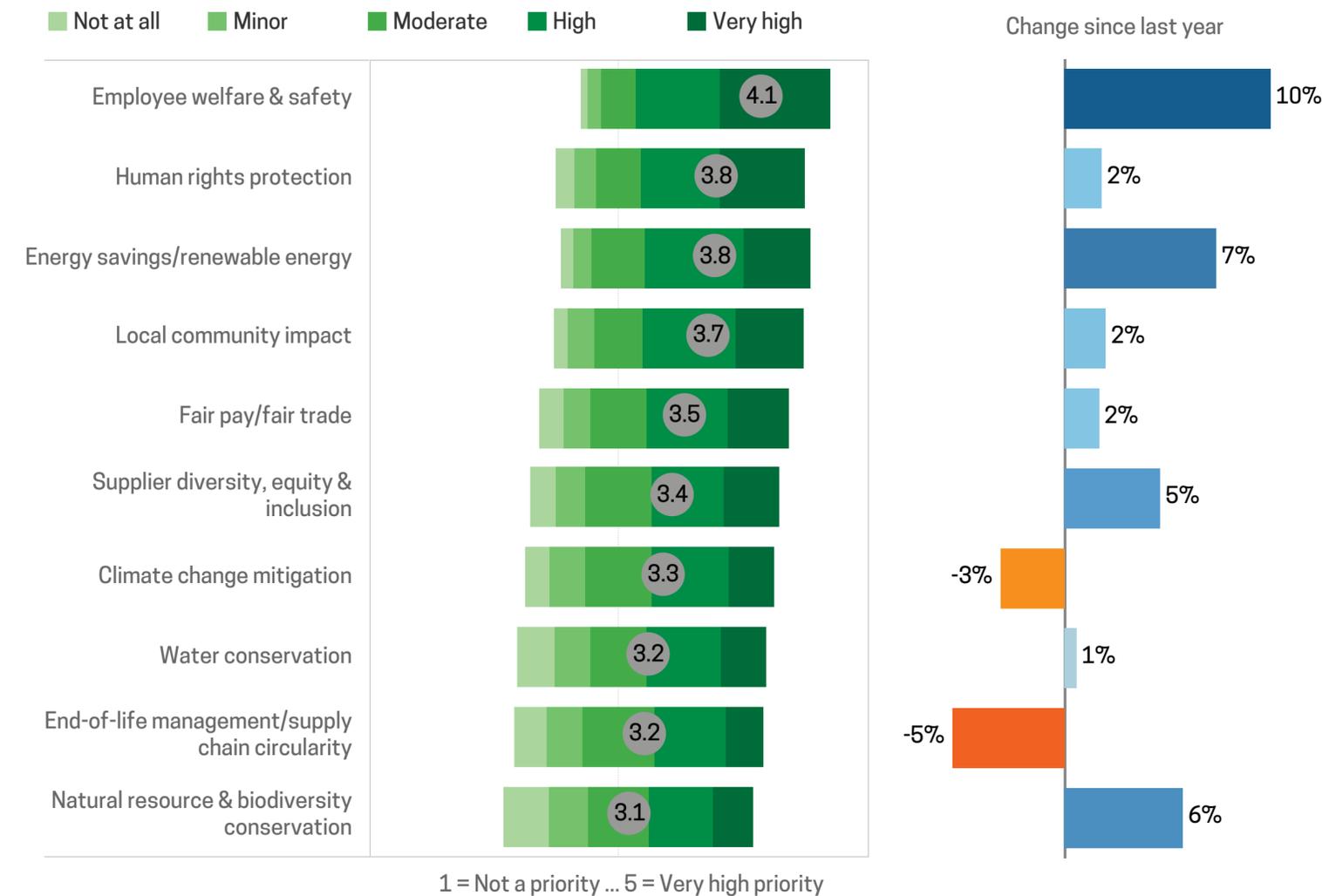| Issue area	Strongest pressure source	Second-strongest pressure source
Climate change mitigation	Company executives	Industry associations
Energy savings/renewable energy	Company executives	Industry associations
Water conservation	Company executives	Industry associations
End-of-life management/supply chain circularity	Company executives	Industry associations
Employee welfare & safety	Company executives	Industry associations
Human rights protection	Company executives	Industry associations
Local community impact	Company executives	Local communities
Supplier diversity, equity & inclusion	Company executives	Local communities
Fair pay/fair trade	Company executives	Industry associations

Sustainability Commitments Increase in Scope

Many companies went public with bold commitments to various sustainability-related goals in 2020. For instance, Microsoft announced its 2030 carbon-negative goal,[37] Walmart promised to become a regenerative company by 2040,[38] and Unilever committed to the use of carbon labels on all its products.[39] There were standout pledges to achieve social goals as well.

> "When a sustainability program is aligned with the purpose of the company and signs up for challenging, ambitious goals, even when the solutions do not exist, they then commit to be a part of the solution through innovation."
> —**Halide Alagoz,** *Chief Product and Sustainability Officer, Ralph Lauren*

To what extent are each of the following issue areas a focus of your firm's supply chain sustainability goals?

Figure 9: Commitment by issue areas related to SCS in 2020 and the change in commitments year over year. The most statistically significant increases (t-test) were in employee welfare at 9.7%, natural resources and biodiversity, 9.8%, and energy savings/renewable energy, 7.1%. there was also a notable dip in end-of-life management by roughly 5.3%. N = 289 (2019) & 794 (2020).

Intel announced new diversity and inclusion goals and increased its spend with diverse suppliers.[40] Nike extended its commitment to traceability and improving human rights protections in its supply chain.[41] These commitments came amid calls for protections and hazard pay for front-line supply chain workers who risked contracting Covid-19. The high-profile announcements stoked the pressure on companies to pay attention to SCS.

When asked why these corporate commitments were prominent in 2020, the 21 supply chain and sustainability executives interviewed for this report had differing opinions, including:

- Commitments were a reaction to pressure from stakeholders in 2019 and 2020.
- Several executives suggested that the beginning of a new decade generally provides an opportunity to transition to new and bold commitments.
- And, notably, they highlighted that the extreme volatility experienced in 2020 provided an opportunity for significant change in organizations, and even accelerated certain programs.

The heightened profile of sustainability-related issues and goals was echoed in our survey. More than half of the respondents (52%) confirmed that their companies have SCS goals, an increase of 4% from the year prior. One-third said their companies do not have SCS goals, and 15% were unsure.

Out of the 10 issue areas included in our survey, commitments increased from last year in eight areas, with the most statistically significant increases seen in employee welfare and safety; natural resource and biodiversity conservation; energy savings and renewable energy; and supplier diversity, equity, and inclusion (see **Figure 9**). Notably, there were decreases in both supply chain circularity and climate change mitigation which is surprising given growing attention to plastics and climate change in the media.

> "I think the other thing that's been really interesting with Covid-19 is the increased inquiry and attention around the S of ESG. Customers want to know: How are you treating your workers?"
> —**Kyra Whitten,** *Vice President of Corporate Marketing, Communications, and Sustainability, Flex*

End-of-life product management and supply chain circularity may have been impacted by an increasing need for disposables due Covid-19 safety precautions.[42] The increased attention paid to social issues may have temporarily sidelined some of firms' climate change efforts.

Our survey results illustrate that commitments to employee welfare and safety grew for all industries in 2020 as companies reacted to employees' safety concerns and risk of exposure to the Covid-19 virus.

Many in the supply chain worked on the front lines of the pandemic, playing a critical role in meeting the need to dramatically increase production of personal protective equipment (PPE)[43] and other medical supplies as well as keeping goods moving in transportation networks to supply dynamic demand.[44] As front-line workers strived to meet these demands, calls emerged for hazard pay and improved health protections.[45]

Commitments to the conservation of natural resources and biodiversity gained ground in 2020, a development that can also be linked to the publicity surrounding these components of sustainability. For instance, the year started with significant media coverage of clear-cutting in the Amazon rainforest for cattle grazing and beef farming.[46] Pandemic-related shutdowns highlighted the environmental impact of transportation and other industries when economic activity sharply decreased, and emissions levels and air pollution plummeted. Natural features usually obscured by smog suddenly became visible.[47] Interest in sustainable agriculture in the form of regenerative farming also received a boost during this time.[48]

The growth in commitment to energy savings and renewable energy is clear. Energy savings often translate into cost savings, and many firms are investing in new supply chain processes and technologies that reduce the cost of energy and its associated environmental impacts. Additionally, the cost of renewable energy has fallen significantly in the last decade, with solar and wind hitting record-low prices last year.[49] These trends make renewables an attractive opportunity for reducing costs and for environmental stewardship.[50]

As can be seen in **Figure 9**, commitments to employee welfare and safety measures showed the greatest increase from 2019 to 2020.

Some of these changes may reflect a temporary refocus on localized issues (employee welfare and safety) as opposed to more global issues (climate change mitigation) as the pandemic forced firms, governments, and individuals to focus on issues that were nearest to them:[51] Rising infection rates, lockdowns, and other pandemic-related challenges brought awareness to social issues which may be reflected in an overall growth in commitments in this area.
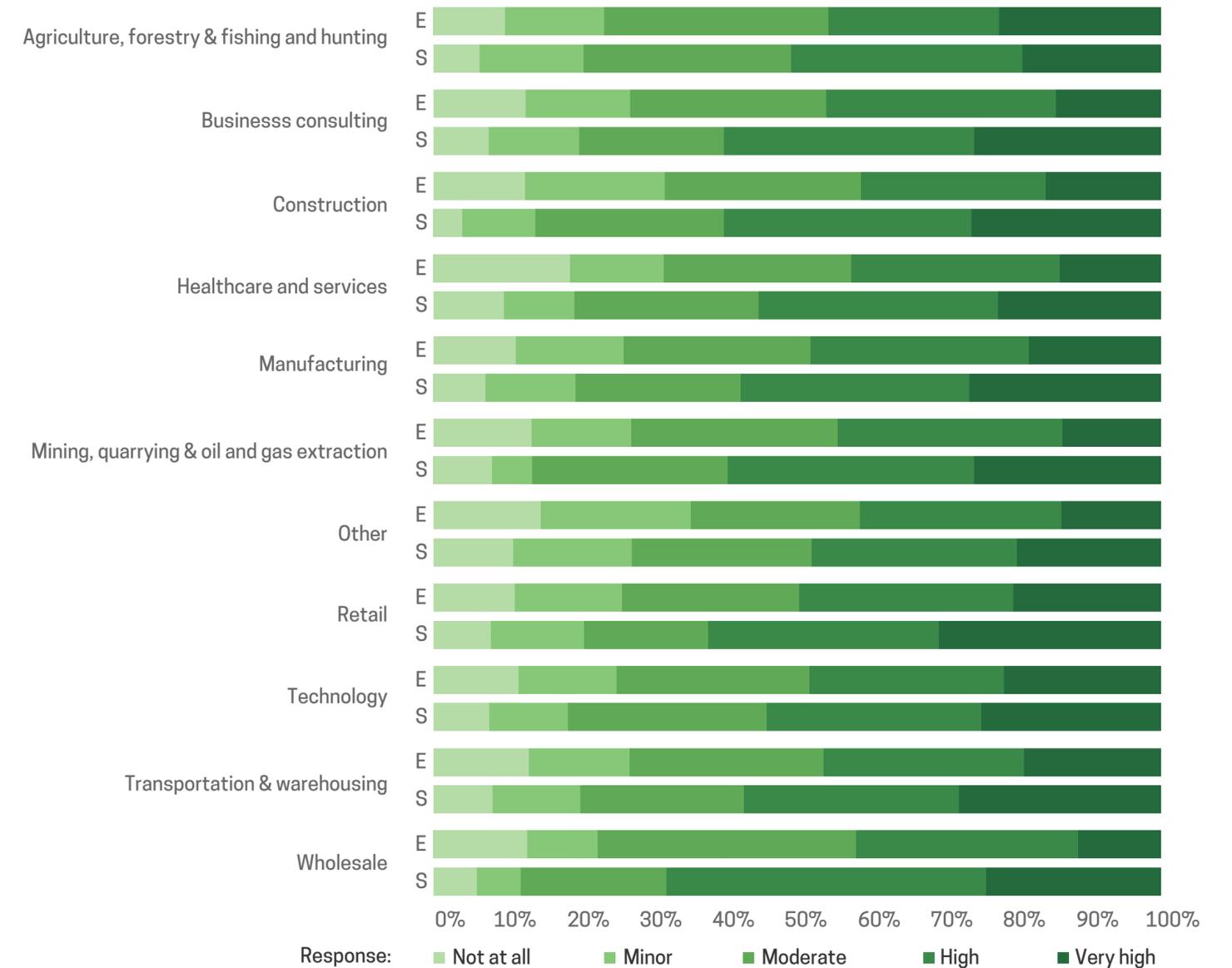
Figure 10: Level of commitment to SCS by industry grouped into environmental (E) and social (S) categories; percentage of total respondence broken down from low to high (colors). N = 794.

For example, it is likely that respondents in transportation and warehousing ranked social issues highly due to concern for quality of life and protections for drivers and warehouse workers. The industry also ranked environmental issues highly, which may be in response to growing awareness of the lack of progress in reducing emissions from transportation combined with growing interest in electric-powered vehicles.[52]

New regulations in road transportation also increased pressure on transportation providers and users, a finding that suggests a relationship between commitments by companies in this industry and regulatory pressures. In June 2019, California's Air Resources Board approved the state's Advanced Clean Trucks regulation, which mandates that 5% of all Classes 7–8 tractors sold be zero-emission vehicles starting in 2024.[53] That percentage increases with each new model year, rising to 40% by 2032. California also is one of 15 states, plus the District of Columbia, that has signed an agreement to cooperate on advancing the electric truck market, with a goal of achieving 100% zero-emission medium- and heavy-duty truck sales by 2050.[54] These regulations reflect growing commitments in the public sphere, which are having an impact on corporate SCS goals.

Investments See Limited Growth

In many ways, the litmus test for companies' degree of commitment to SCS is whether they "walk the walk" by backing their promises with tangible investments. Our research shows that while there have been bold commitments in the public sphere, there has been limited change in companies' willingness to invest in SCS programs.

The percentage firms that invested in SCS increased by a mere 1.4% to reach 58.7% (see **Figure 11**). The lack of progress in SCS investments may reflect the financial impact and risks associated with the Covid-19 pandemic.[55] In addition, we found that small- and medium-sized firms—which were hit harder by the pandemic— invested fewer financial or human resources in sustainability efforts.[56]

Has your company invested in supply chain sustainability?
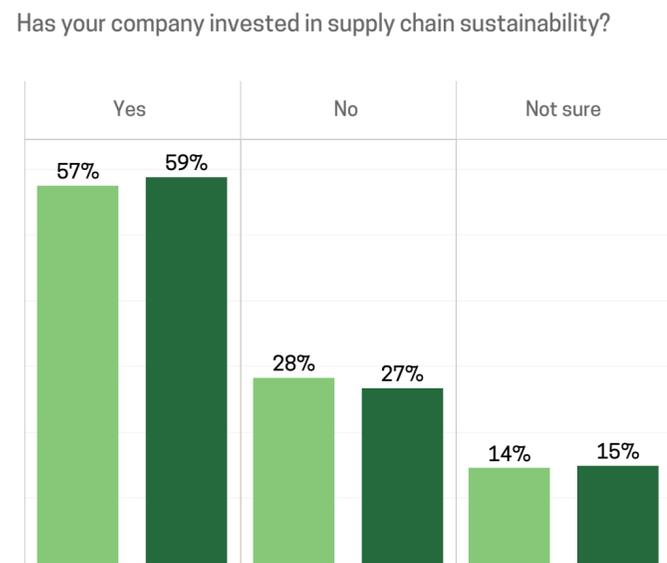
Figure 11: Year-over-year change in SCS investment in 2019 and 2020; totals may not sum to 100 due to rounding. N = 614 (2019) & 1,557 (2020).

The findings related to patterns of investment were more striking (**Figure 11** and **Figure 12**). The biggest gains between 2019 and 2020 were investments in human rights protection, employee welfare and safety, and supplier diversity. This finding was corroborated in interviews with executives. More than half of respondents in our executive interviews said that social issues were prominent in much of the effort they devoted to SCS in 2020.
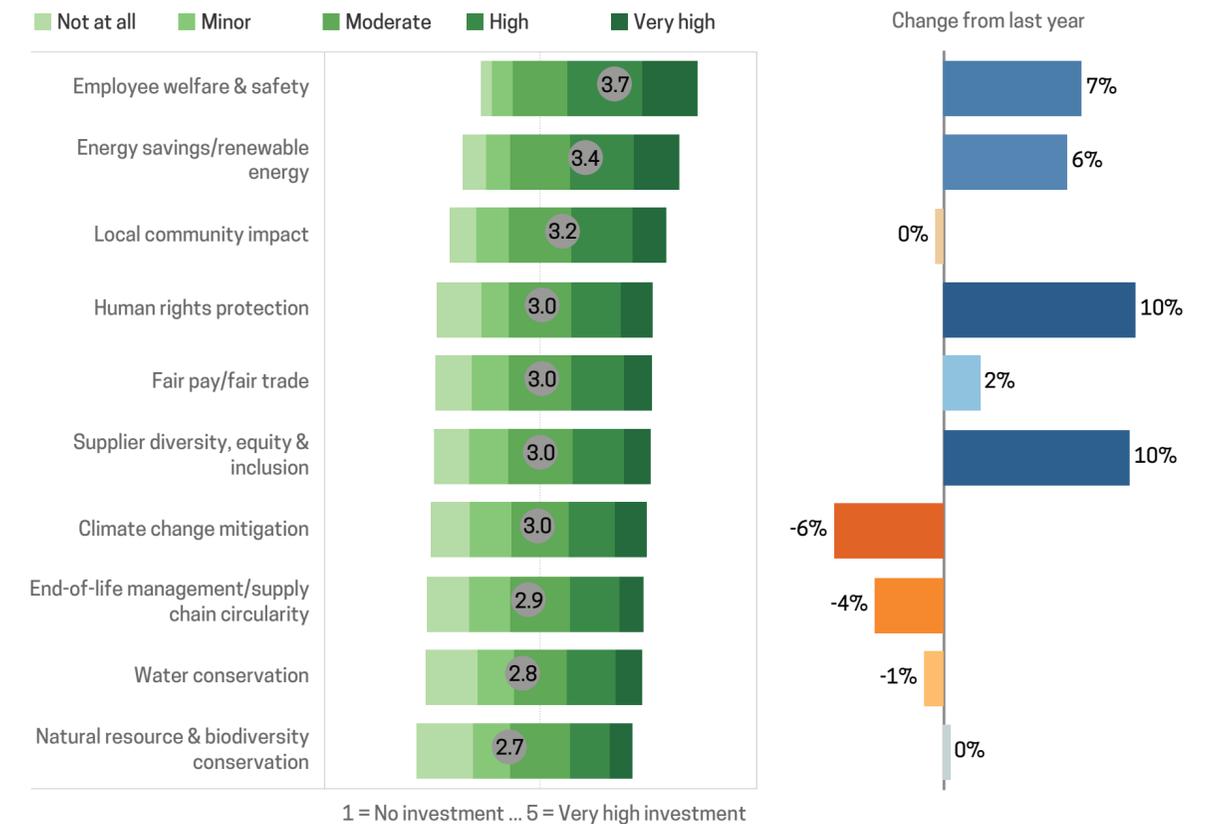
Figure 12: Investments in 2020 and change year over year from 2019 to 2020. The majority of investments for 2021 either remained steady or increased. Statistically significant changes were in human rights (10%), supplier diversity (9.8%), welfare and safety (7.1%), and energy savings (6%). There was a notable dip in climate change mitigation by roughly 5.7%. N = 348 (2019) & 904 (2020).

The emphasis on social issues is likely related to the increasing importance of these issues in the public sphere and related media coverage. Poor working conditions attracted significant public interest, as did human-trafficked labor, and most notably, forced labor in Xinjiang, China. Reports about the treatment of Uyghur factory workers[57] drove many companies to react swiftly by reducing the risk of being complicit in the alleged human rights violations.

Covid-19 outbreaks in production facilities, notably in meatpacking sites in the US, also garnered many headlines that ratcheted up the pressure on companies to protect their workers.[58] Social justice protests became widespread globally following the murder of George Floyd in the US,[59] prompting firms to invest in diversity, equity, and inclusion programs.[60]

While social investments were top of mind, environmental investments in the form of energy savings and renewable energy programs saw a large gain as well. Many companies increased their reliance on renewable energy in their operations and started to drive these investments into the supply chain.[61] However, investments in climate change mitigation dropped 6% from 2019. This result may seem counterintuitive given the prominent commitments made by many companies to achieving net-zero carbon emissions and meeting science-based reduction targets.[62] However, these goals frequently focus on areas where companies have direct control (i.e., Scope 1 and 2 emissions[63]) and not their supply chain emissions (i.e., Scope 3), which are out of their direct control.

While investments across industries shifted from 2019 to 2020, the wide gap between the SCS-related goals that companies committed to—and the investments required to fulfill these goals—did not change. The shortfall in human rights, fair pay, fair trade, and local community investments was particularly striking. This mismatch is detailed in **Figure 13**, which shows the difference between commitment and investment as an average (red dot) and distribution (plot area) for each issue, with zero indicating no difference.

A notable example in the real world is how chocolate companies were called out for failing to commit adequate resources to meeting their publicly stated goal of rooting out child labor in cocoa production.[64] Similar stories can be found in other industries such as apparel, where failures have not been properly addressed owing to a lack of investment. For instance, promises to improve working conditions were made after the 2013 Rana Plaza factory collapse in Bangladesh, yet instances of human rights violations are still frequent.[65]

In contrast, commitments and investments on environmental issues are more closely correlated, with the energy sector leading the way. This is partially due to the potential for cost reductions through energy savings and the increasing affordability of renewable energy options. Investments in solutions to social problems are often harder to identify, quantify, and implement.[66]

Figure 13 (right): Comparison of goals vs. investment in different issues areas between 2019 and 2020. The violin chart demonstrates the difference between level of investment and level of commitment and how those responses are distributed away from the mean. The dot is the average difference, showing a more significant difference for human rights and social issues in general, but a better alignment at 0 can be seen for environmental issues, especially with energy. N = 1,252.

Difference between level of commitment and investment

Investment greater than goals — 2020 — Goals greater than investment

- Human rights protection
- Fair pay/fair trade
- Local community impact
- Supplier diversity, equity & inclusion
- Employee welfare & safety
- Water conservation
- Climate change
- Natural resources & biodiversity conservation
- End-of-life management
- Energy savings/renewable energy

2019

- Human rights protection
- Fair pay/fair trade
- Local community impact
- Supplier diversity, equity & inclusion
- Employee welfare & safety
- Water conservation
- Climate change
- Natural resource & biodiversity conservation
- End-of-life management
- Energy savings/renewable energy

value

Practices: A Mixed Bag

We surveyed professionals on which practices they used in their SCS efforts. The most common ones include company and supplier codes of conduct, supplier collaboration, sustainability standards and certification, improvements in visibility and traceability, supplier audits, supply chain mapping exercises, supplier benchmarking, third-party verifications, supplier training programs, and collaborations with NGOs and other third parties.

According to the survey, 58% of firms use one or more of these practices, and as seen in **Figure 14**, the use of codes of conduct (firm and supplier) is the most common practice. Supplier collaboration and sustainability standards were also high on the list in 2020, with mixed trends from 2019 with a 2% decrease in the use of standards and 2% increase in collaboration.

Visibility and traceability saw the greatest increase, with a gain of 3% from 2019 to 2020, which may have been driven in part by outages and supply chain disruptions.[67] The adoption of audits dropped by 4% owing to the challenge of visiting supplier sites amid Covid-19-related restrictions.[68]

To better understand how practices are being used in combination, we used correlation-based groupings (see **Figure 15** and Practice Groupings section in **Appendix A** for more information on the approach) to quantify which practices were most commonly selected together. Three distinct practice groups came out of this analysis: supplier development, supply chain visibility, and environmental impact reduction. The first and most frequent group of practices was supplier development, which included supplier codes of conduct, audit, benchmarking, third-party verification, and supplier training and collaboration. The next practice group includes supply chain mapping and visibility/traceability. The third practice group was an environmental impact reduction cluster, including environmental technologies and carbon offsets. Three other practices are not used consistently with other practices: sustainability standards and certificates, NGO or third-party collaboration, and information technologies.

Which of the following practices does your firm have in place to manage SCS?
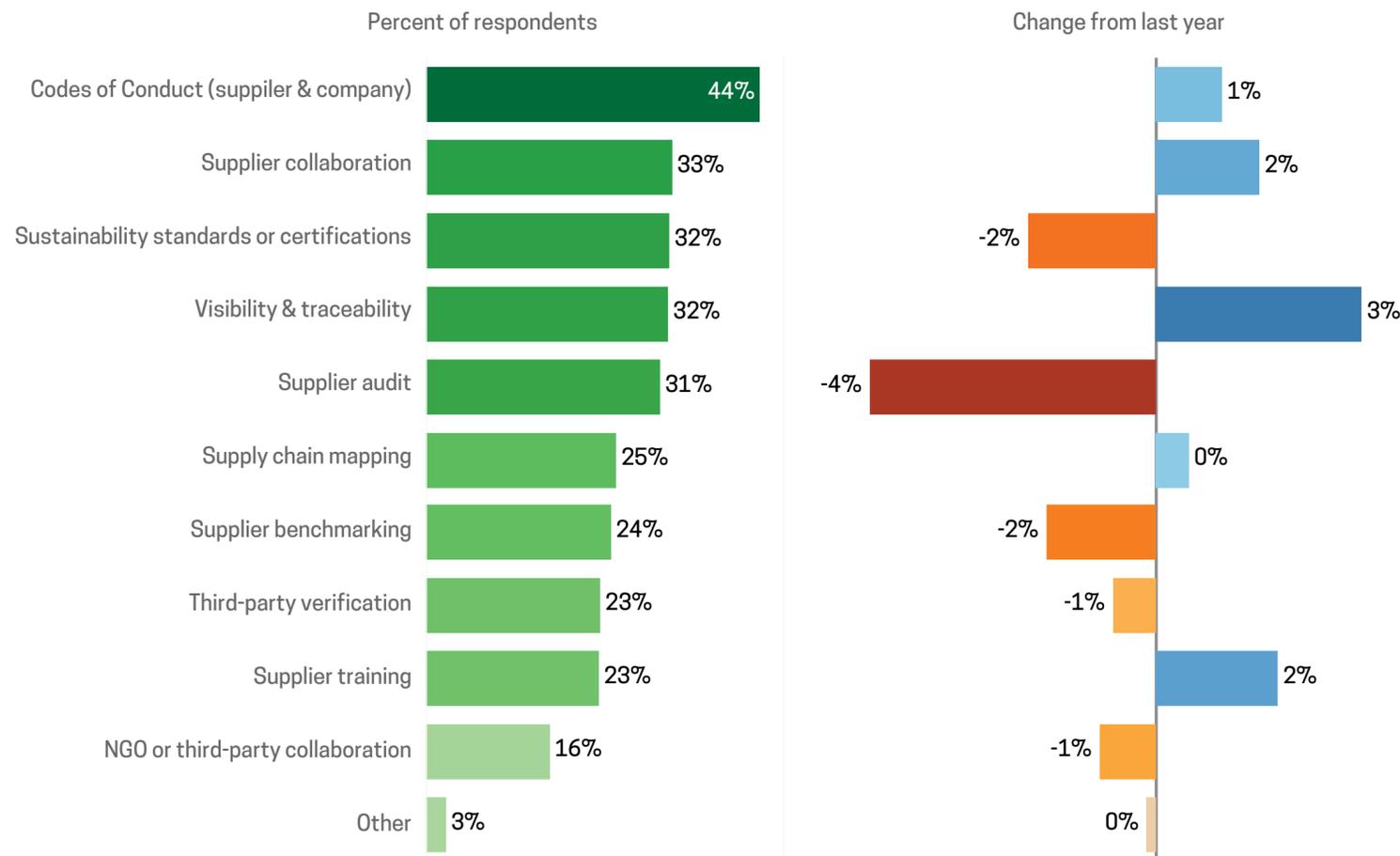
Figure 14: Practices in 2020 and year-over-year change from 2019 to 2020. N = 616 (2019) & 1,561 (2020).

Figure 15: Graphical representation of SCS practices and correlation-based groupings. Three main groupings emerge. N = 1563.

The practice groupings of **Figure 15** are summarized as:

Group 1: Supplier Development

Company & Supplier Codes of Conduct, Supplier Training, Supplier Audit, Third-Party Verification, Supplier Benchmarking, and Supplier Collaboration

Group 2: Visibility

Supply Chain Mapping and Visibility & Traceability

Group 3: Environmental Impact Reduction

Carbon Offsets, Environmental Technologies, Independent Practices, Sustainability Standards & Certifications, NGO or Third-Party Collaboration, and Information Technology

These groupings provide insights into how firms are attempting to reduce their social and environmental impacts. Within the supplier development group, companies are heavily focused on requiring and verifying relevant supplier practices and helping their suppliers adopt and maintain more sustainable practices through collaboration and training. The visibility group demonstrates that firms are keen to get more information about practices and activities deeper in their supply chains. The environmental impact reduction group shows there is a focused effort on minimizing environmental impacts beyond supplier development efforts.

> "Engaging with our suppliers across the value chain has meant that we've had to evolve our mindset from one of compliance into one of competitive advantage. This provides us with the opportunity to work with our suppliers to identify the right target for them and hold each other accountable in our shared ambition."
>
> **–Ella Chan,** *Vice President for Strategic Initiatives, Sam's Club*

We also see interesting patterns when breaking down these practices by industry (see **Figure 16**). By and large, supplier development has the highest adoption across industries. This may be representative of the fact that as firms seek to improve their supply chain sustainability, they may need to bring their suppliers along with them on this journey. This cluster includes mandates (codes of conduct and supplier audits), supplier competition (supplier benchmarking), and support (supplier collaboration and training). It is clear that a suite of tools is being used to manage suppliers' SCS commitments and progress.

Pandemic issues may have had an impact here, as smaller suppliers negatively impacted by the crisis needed further support from their buyers.

Percentage of companies that have adopted an SCS practice

	Environmental impact reduction	Supplier development	Visibility
Agriculture	25%	30%	33%
Business consulting	10%	19%	23%
Construction	14%	21%	17%
Healthcare	15%	27%	29%
Manufacturing	25%	36%	35%
Mining	21%	33%	25%
Retail	25%	29%	34%
Technology	21%	28%	28%
Transportation	33%	30%	37%
Wholesale	12%	33%	36%

Figure 16: *The application by industry of different practice clusters represented as a heatmap of the average percentage of companies that have adopted this practice (respondents can select more than one practice). Darker shades indicate more heavily used practices. N = 1,561.*

The visibility practice group is most common in transportation, manufacturing, and wholesale industries. We also found that the transportation industry is most likely to use environmental impact reduction practices. In addition, retail, agriculture, and manufacturing industries apply the environmental practice group at higher levels.

Jim Hartzfeld, Head of Sustainability, North America, for Brambles Limited, echoes this finding: "Near real-time tracking and tracing of goods and transportation assets across multiple supply chains enhances product visibility, stock control, transport efficiency, and asset productivity—all creating more economic and environmental value."

> "We work with many manufacturers of specialized materials, some of which are smaller companies or private firms that may not have mature sustainability programs. For these suppliers, we try to educate them about requirements, set reasonable expectations, and provide clear instructions for how they can assist us in our efforts."
>
> **–Andrew Pastor,** *Director of Sustainability, Waters Corporation*

These results corroborate what we learned in executive interviews. Supplier engagement may be a clear goal, but it is also a barrier for many industries when seeking to drive SCS along the supply chain. In short, suppliers are both the barrier and opportunity in achieving SCS.[69] Efforts to improve visibility are increasingly common in certain industries that want to monitor SCS-related practices deeper into the supply chain to ensure compliance.

Reporting & Disclosure Practices Largely Static

Reporting and disclosure of SCS is an important step in measuring progress (or lack thereof) and being transparent with external stakeholders. Companies can share this information on their websites, in press releases, in formal corporate social responsibility/sustainability reports, and through external reporting to organizations such as CDP (formerly the Carbon Disclosure Project). According to a survey of 250 companies by KPMG, approximately 80% of companies had some form of general sustainability reporting process in 2020.[70] This picture changes a bit when set in regards to supply chain sustainability in specific which has lower overall reporting.

Does your firm disclose SCS practices?

Yes		No		Not sure	
44%	45%	42%	35%	14%	20%
2019	2020	2019	2020	2019	2020
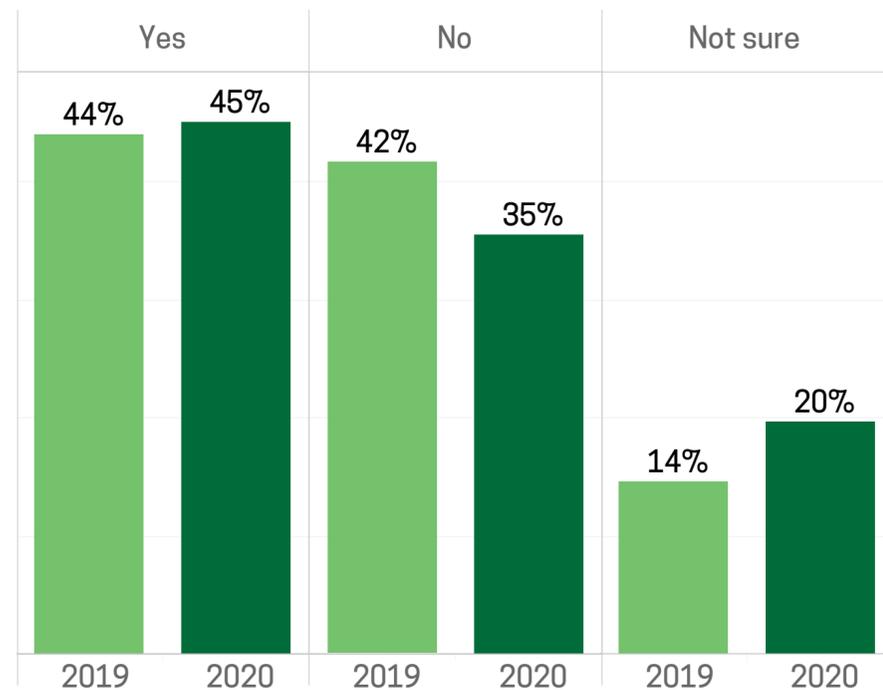
Figure 17: Reporting and disclosure did not change markedly between 2019 and 2020. There were no statistically significant changes seen year over year. Totals may not sum to 100% due to rounding. N = 614 (2019) & 1,557 (2020).

We found that reporting and disclosure practices did not change substantially in 2020 from the year prior (see **Figure 17**). Almost half (45%) of survey respondents said their firms disclosed progress in 2020, an increase of only 1% (not statistically significant) from 2019. More than a third of respondents said they did not disclose progress. The remaining 20% said they were not sure if their company did so, which is 6% more than the previous year.

While the proportion of firms reporting and disclosing supply chain sustainability impacts was relatively stable, overall rates of disclosure varied by geography.

As can be seen in **Figure 18**, Europe has the highest rates of reporting overall. In 2014, requirements increased in the European Union with Directive 2014/96/EU for the non-financial reporting of sustainability practices, including a range of environmental, social, and governance components. In 2020, European organizations held initial discussions about increasing the directive's scope and released a preview of a modified version. Such a change will likely drive higher levels of voluntary disclosure in EU in advance of these requirements.[71]

How often does your firm disclose its supply chain sustainability practices?
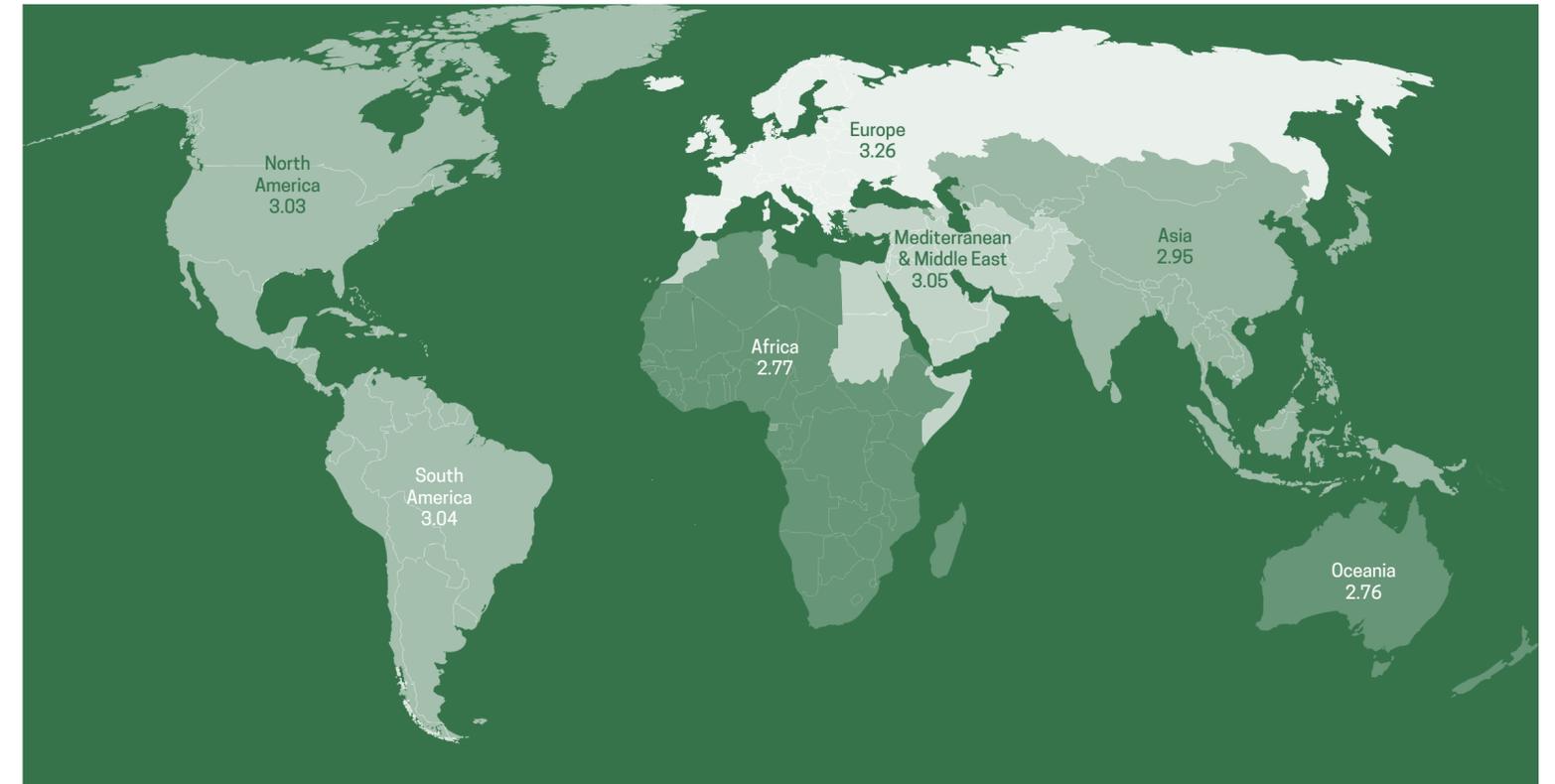
Figure 18: Geographical representation of disclosure and reporting rates based on the average of Likert scale (1 to 5) responses, with 1 indicating "not at all" and 5 indicating "very often". N = 1,557.

As can be seen in **Figure 19**, with the exception of changes to CSR/sustainability reporting—there was no statistically significant shift here—reporting of SCS progress did not change substantially from 2019 to 2020 for company-owned mediums including websites and press releases. Using these channels remains popular in part because they are directly managed by the companies involved. There was substantially less disclosure of practices when firms reported to external organizations such as CDP. These outside organizations can be more rigorous, especially for firms that have historically avoided disclosing their progress on SCS.

How often does your firm disclose about its supply chain sustainability practices using each of the following channels?

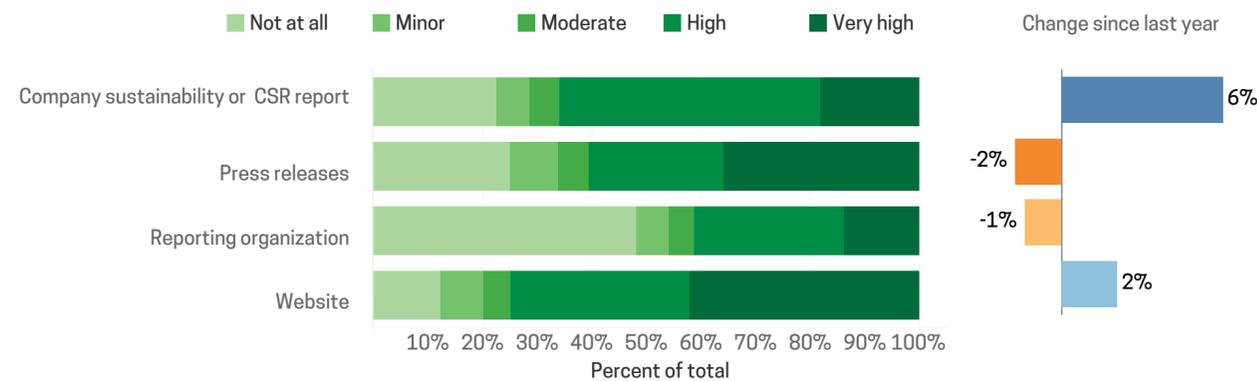*Figure 19: Reporting for SCS by firms in 2020 and change from 2019 to 2020; N = 268 (2019) & 687 (2020).*

These findings mirror the significant disclosure gap seen for supply chain emissions. Over 5,000 of the world's largest companies disclose emissions to CDP, for example, but less than 20% disclosed freight transportation emissions in 2019.[72] This disclosure gap is compounded by the magnitude of emissions from supply chains. According to CDP's *Global Supply Chain Report 2019,* GHG emissions from supply chains were 5.5 times greater than direct (Scope 1 and 2) emissions.[73]

> "Due to an increase in corporate adoption of ESG reporting, we have seen a progression towards an increased scope and accuracy of reporting. Concurrently, we are sensing a shift in the drivers of sustainability from a response to external pressure to an opportunity to differentiate themselves."
> –**Robert Barrett,** *Principal of Advisory Supply Chain and Operations, KPMG LLC*

The lack of progress in reporting and disclosure practices, despite high levels of commitment, may be due in part to firms focusing on assessing their SCS impact and designing public goals for the next decade rather than more formal reporting. Disclosures may gain more attention as firms learn to measure how they are achieving their commitments with key performance indicators and start to disclose their progress publicly.

Supply Chain Sustainability Firm Typology

A critically important feature of our annual *State of Supply Chain Sustainability* is that it evolves in line with shifting market demands and conditions and as we develop new analytical approaches. In this second report, we have taken a significant step with the introduction of a classification system for companies called the **Supply Chain Sustainability (SCS) Firm Typology.** We believe this new classification will enable us—and the wider supply chain community—to better analyze and understand the trends that are driving SCS.

The *State of Supply Chain Sustainability* survey explores SCS behavior across four survey dimensions: pressure, commitment, investment, and disclosure. The results suggest that there are certain "types" of companies in terms of how they view and manage SCS. To test this hypothesis, we applied a machine learning model (*k*-means clustering) to survey data from 2019 and 2020 (for a graphical representation of clusters and the methodological approach, see **Appendix A: Clustering**). The model identified six clusters, or types of companies, based on their profile for supply chain sustainability gauged in the survey.

Using the distinctive characteristics of each cluster, we created designations for the different types of companies in our SCS Firm Typology. The enterprises range from those with lower SCS scores (Low Effort, Dreamer, Compliant organizations) to trailblazers (Standard, High Effort, Leader organizations). The full classification is described below. To gain insights into their behavior, we then explored the characteristics of these SCS company types by different survey measures including pressure, investment, disclosure, firm size, and whether they are public or private enterprises. The clusters were fairly evenly distributed across industries.

The different company types and their respective characteristics are:

- **Low Effort:** Low across all areas of pressure, commitment, investment, employee engagement, practices, and disclosure.

- **Dreamer:** Moderate commitment and practice application, but low pressure, low investment, engagement, and low disclosure.

- **Compliant:** Low commitment and disclosure, but moderate pressure, investment, engagement, and practices.

- **Standard:** Moderate across all areas of pressure, commitment, investment, employee engagement, practices, and disclosure.

- **High Effort:** High commitment, investment, and disclosure, but low pressure.

- **Leader:** High pressure, commitment, investment, employee engagement, and disclosure.

One way to visualize how the clusters compare across each general measure and the specific issue areas within each area can be seen in **Table 2**. Leaders score high across all issue areas and are typically large companies with highly engaged employees (see **Figure 20**). They are also more likely to have practices in place to manage their SCS efforts.

In contrast, the High Effort cluster stands out with lower levels of pressure to adopt SCS despite highly engaged sustainability professionals; strong SCS practices; and high levels of commitment, investment, and disclosure. They are also more diverse in size than Leaders.

Table 2: *Firm typology clusters: Heatmap showing average scores for each firm typology based on the clustering of results. Scores are color coded and categorized as Low, Moderate, or High for simplicity. N = 1,223. See more detailed heatmap of clustering results in* **Table 5** *in* **Appendix A***.*

	Low Effort	Dreamer	Compliant	Standard	High Effort	Leader
Pressure to act	Low	Low	Moderate	Moderate	Low	High
Commitment	Low	Moderate	Low	Moderate	High	High
Investment	Low	Low	Moderate	Moderate	High	High
Employee engagement	Low	Low	Moderate	Moderate	High	High
Practice application	Low	Moderate	Moderate	Moderate	High	High
Disclosure	Low	Low	Low	Moderate	High	High
Company size	Small & medium	Sm., med., lg., very large	Sm., med., lg., very large	Large & very large	Lg. & very large (⅔ sm. & med.)	Very large

SCS Firm Typology Clusters by company size

	Small (0-99)	Medium (100-999)	Large (1000-9,999)	Very large (10,000+)
Leader	16	17	34	119
High Effort	24	24	28	54
Dreamer	33	32	33	56
Compliant	43	44	34	35
Standard	27	34	54	120
Low Effort	128	102	91	41

Figure 20: *SCS firm types by company size. N = 1,223.*

In contrast, large, public-facing companies can devote substantial resources to sustainability initiatives, and many of their employees are involved in the effort. As small companies grow, however, so does their potential to become more impactful SCS players, and they may experience more pressure to act. This evolutionary process from lower-effort to higher-effort company types is a potential direction for future research.

On the other side of the spectrum, Low Effort firms score the lowest across all measures. They tend to be small- and medium-sized enterprises with the lowest level of engagement from their staff and are unlikely to have SCS practices in place. Interestingly, firm types are represented evenly across all the industries studied. Each group had a similar mix of industry representation that was close to the overall survey sample. This means that these six clusters could be viewed as SCS stepping stones. Small, private companies in the lower-effort groups may not have the time or resources to achieve significant progress toward SCS.
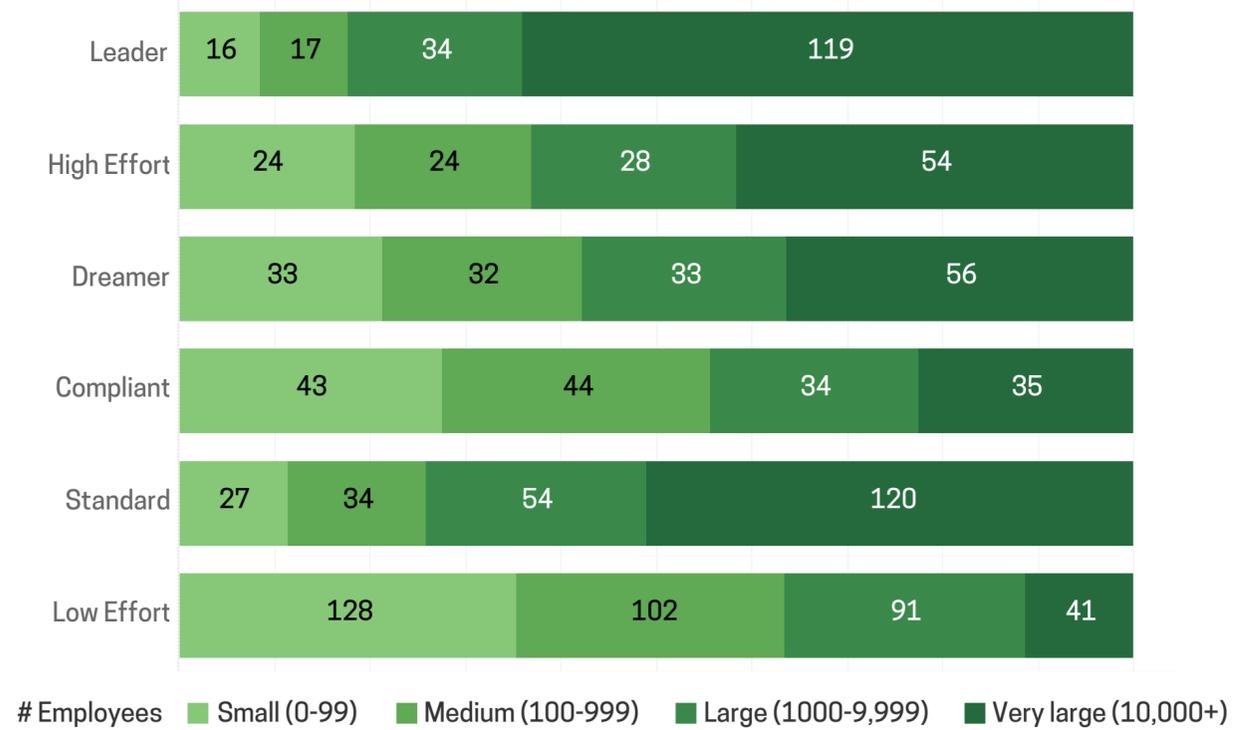
Supply Chain Professional Engagement

It is self-evident that supply chain professionals are central to the drive toward sustainable supply chains. However, the nature of that engagement is still evolving as SCS advances within companies and in the wider business community. The Covid-19 pandemic added a societal dimension to this evolutionary track, as the term supply chain gained common currency.

Jane Franch, Vice President for Strategic Sourcing & Sustainability at Numi Organic Tea, describes the implications for practitioners: "Supply chain professionals are gatekeepers to change. They hold tactical knowledge on how systems work and valuable insights on both motivating and limiting conditions. It is essential that they are better integrated into and empowered in sustainability decision making. This requires thoughtful and sincere redefinition of performance goals and targets, which too often are limited to on-time, cost-efficient fulfillment/delivery and transactional outcomes."

Our research findings support these sentiments. We identified a shift toward integrating supply chain professionals into corporate sustainability efforts—rather than in separate sustainability departments—in our inaugural report, and the current report reaffirms this shift. Moreover, we found that more SCM practitioners are engaged in sustainability initiatives compared to the prior report.

> "Supply chain organizations are no longer thought of as cost centers but [as] foundational to growth transformation as a roadmap for sustainable supply chains."
> –**Sheri Hinish,** *IBM Global Partner & Practice Offering Leader,*
> *Sustainable Supply Chain + Circularity*

Respondents' level of engagement with their firm's SCS efforts
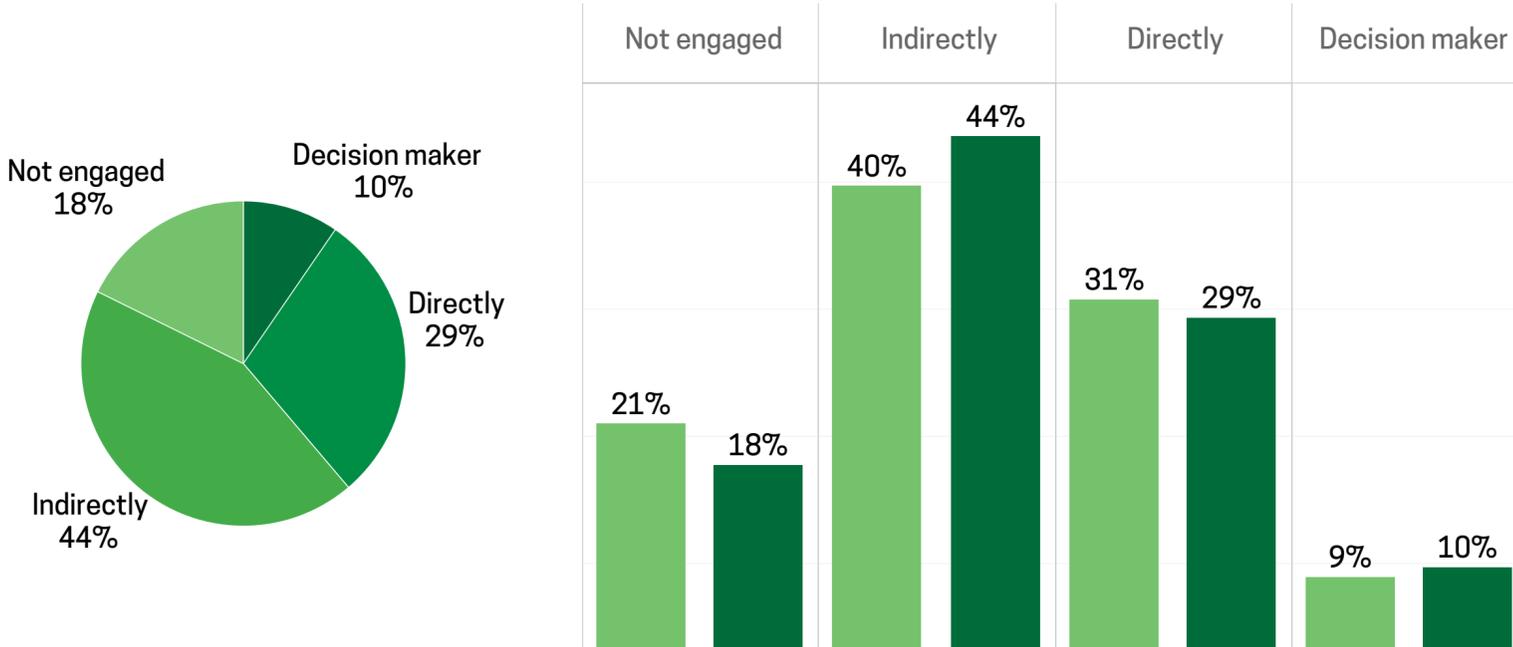
Figure 21: Respondents' level of engagement in supply chain sustainability in 2019 and 2020. N = 611 (2019) & 1,526 (2020).

Although the nature of our survey may be biased toward professionals who are already involved in sustainability, almost half of those we surveyed are decision makers or directly involved in sustainability initiatives (see **Figure 21**). The largest share (44%) is indirectly involved, an increase of 4% from last year. This may be due, in part, to the realignment of business priorities as supply chain professionals were called to serve on the front lines of the pandemic and grapple with unprecedented operational disruptions.

> "Supply chain professionals have a large role to play in sustainability, in driving sustainability as one of the top metrics being tracked for the health of the business. Supply network decisions impact not only the total shareholder returns metrics but also in terms of sustainability metrics. How supply chain professionals respond (short- and long-term) in terms of different scenarios has a lasting impact on sustainability."
> –**Hong Mo Yang,** *Senior Vice President and General Manager of Manufacturing Sector, Blue Yonder*

As was the case in last year's report, our current research shows that the level of practitioner engagement in sustainability programs is not consistent across industries. Supply chain professional engagement decreased the most in the manufacturing and transportation & warehousing industries. The decrease may reflect a shift in priority during the pandemic.

Retail professionals were also on site, but their level of engagement declined less, reflecting the broader trend we found with the retail industry experiencing the most pressure to be more sustainable. In response, retail supply chain professionals have become more engaged in sustainability initiatives, and the broader industry has established more aggressive commitments and investments in SCS. According to the results, healthcare professionals were also more engaged in SCS potentially reflecting heightened interest in PPE and vaccine supply chains.

Respondents' level of engagement with their firm's SCS efforts by industry   How has it changed from last year?
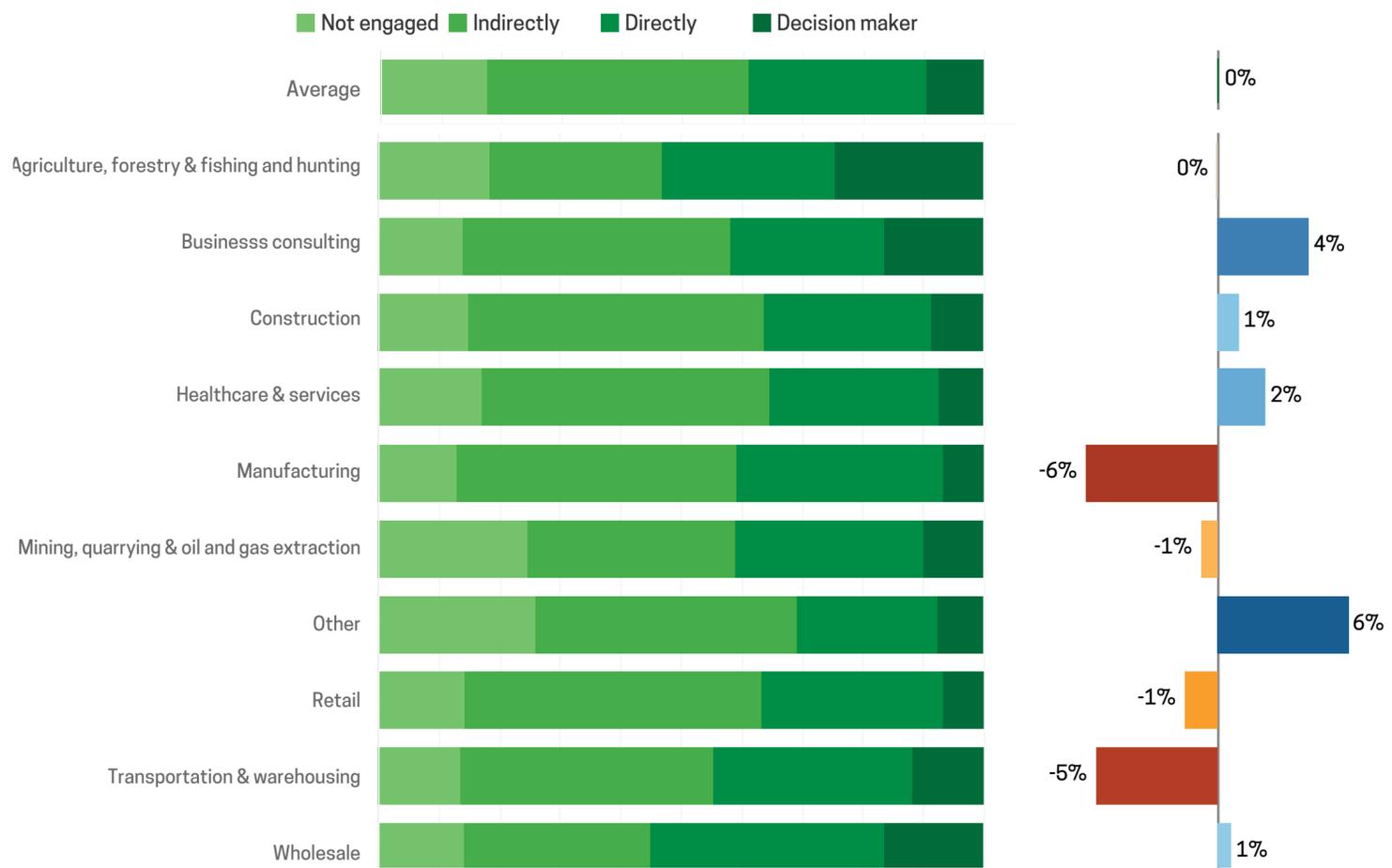
■ Not engaged ■ Indirectly ■ Directly ■ Decision maker

Figure 22: Respondents' SCS engagement by industry and change year over year. N = 611 (2019) & 1,526 (2020).

Future Outlook

THE INAUGURAL *STATE OF SUPPLY CHAIN SUSTAINABILITY* WAS PUBLISHED IN THE EARLY months of the Covid-19 pandemic. The data captured in this second report reflects the first year of the pandemic's impact. Although Covid-19's lasting impact on supply chains and SCS is still playing out, our current research offers a glimpse of the evolving effects of the pandemic and their implications for sustainability in supply chains.

SCS's Star Will Continue to Rise

There was wide agreement among the people we interviewed and surveyed for this report that interest in SCS will continue to increase in the near term. This finding is good news from a sustainability momentum standpoint. However, more interest is likely to bring more scrutiny from stakeholders like investors and customers—which is warranted. This may not be a positive outcome for companies that up until now have chosen not to engage with SCS; these include Low Effort and Dreamer companies as depicted in our SCS Firm Typology. There is likely to be more pressure generally to deliver on SCS promises and report on that progress year over year. In addition, enterprises that have not focused on SCS may feel increasing pressure to join the effort.

Pamela Mar, Executive Vice President for Knowledge and Applications for the (supply-chain-focused) Fung Group, agreed that SCS is increasing in importance, a shift she feels is permanent. "Pre-Covid," she said, "consumers were becoming aware, but companies could still operate in the 'bulge middle', where they make the right sounds but basically pursue business as usual." Covid-19 changed all that by, for example, driving increased attention to social issues and climate and facilitating the shift to digital commerce. She further suggests that these trends "are leading companies to understand that they do need a sustainability story backed by substance."

A key part of that story is likely to be improvements in supply chain transparency and disclosure. These are essential tools in the SCS toolbox. Also, important will be a willingness to go beyond the basics. It is notable that when asked what distinguishes the most progressive supply chain sustainability programs in their industry, a majority of the executives interviewed pointed to programs that go beyond compliance, deliver measurable results, and seek to redefine a process or practice.

Supply Chain Will Be Central to the Story

As we describe in this report, supply chain professionals play a critical role in SCS. And this role will, if anything, only take on more significance. Dr. Donna Palumbo-Miele, Founder of Concordia Supply Chain Group LLC and Chair of the CSCMP Sustainable Supply Chain Group, echoes this point: "The role of supply chain professionals has been evolving and will continue to do so. As leaders, it is our responsibility to foster an environment for supply chain professionals to be change agents."

A key part of this role will be helping companies overcome the many formidable barriers to supply chain sustainability that lie ahead. These impediments vary by company and industry, but our research identified some common threads. An example is the challenge of securing the active support of suppliers, especially in large, complex supply bases that encompass broadly different corporate agendas and levels of sophistication in the sustainability area. Aligning sustainability goals across supply chains is another hurdle that will challenge practitioners in the future.

Investors Want a Seat at the Sustainability Table

Investors will increasingly turn their attention to sustainability. In the US, there was a record flow of capital into US Environmental, Social, and Governance (ESG) funds in 2020, and the Biden administration has signaled that climate change is an immediate priority.[74] Investors' growing participation and scrutiny of companies' SCS track records is reflected in our research for this report.

Social Sustainability Will Stay Top of Mind

Social issues came into focus in 2020. Social justice protests, heightened awareness of forced labor, and social inequalities laid bare by the pandemic are some of the developments that have helped to increase the pressure on companies to address social issues. As we recover from Covid-19 and start to rebuild our economies, these areas will likely stay in focus.

Michael Milam, Chief Operating Officer of Dr. Bronner's Magic Soaps, described operating through pandemic constraints as a "moral calculus" where some sustainability commitments had to be temporarily sacrificed to achieve others. For instance, they had to use some bottles not made with post-consumer recycled plastics—which went against their longstanding policy—to continue supplying soaps and sanitizers for employee and public safety when their regular sources of PCR bottles were constrained. Economics also played into

this calculus with their need to maintain their business in order maintain a steady demand and thus not adversely affect the livelihoods of their fair-trade material suppliers.

This concept of "moral calculus" is likely to be a key issue going forward for firms. Companies may need to juggle the needs and trade-offs of investing in different sustainability dimensions from social issues like worker welfare and safety that are increasingly in focus with the pandemic to environmental commitments such as climate change mitigation and product stewardship.

Climate Change Mitigation May Define the Coming Decade

A key question is the degree to which companies' recent net-zero commitments will translate into SCS initiatives over the next five years. This is especially pertinent in light of our finding that climate change mitigation was a lower priority for firms in 2020.

Companies' increased investments in energy savings and renewables have laid the groundwork for emissions reductions in supply chains, but some of the most difficult challenges, such as decarbonizing ocean shipping, lie ahead.

These challenges to address climate change and broader sustainability are echoed by MIT professor Yossi Sheffi, Director of MIT Center for Transportation & Logistics: "The jury is still out on what the impact of the Covid-19 pandemic will be on corporate priorities, but our initial results suggest that sustainability did not drop as much as we anticipated. As consumers look toward a return to normalcy and companies grapple with continued supply chain disruptions, the key question will be whether supply chain sustainability remains a tack-on to existing CSR efforts or if it can be embedded strategically to drive risk management and opportunities that more concretely contribute to climate change mitigation."

Bringing Small- and Medium-Sized Enterprises Along

Our research indicates that while large and very large companies are moving steadily in their sustainability commitments—albeit with investments lagging—many small- and medium-sized companies struggled to make progress in 2020. An important goal is to gain a better understanding of the critical barriers that prevent small and mid-size enterprises (SME) from adopting sustainability and how these enterprises can be engaged. In addition, companies that do business with small- and medium-sized suppliers have an opportunity to incorporate these enterprises into their sustainability efforts to increase overall adoption.

CONCLUSION

The research carried out for the first two reports in this annual series shows that while the business community is only at the beginning of its SCS journey, the movement is maturing, and its constituency of vested interests is expanding. As industries carve their own SCS paths forward, global transparency will play a vital role in guiding long-term development and vision. Future sustainability aspirations cannot be achieved by any single company but rather by the alignment and coordination of many diverse interests.

Next year's report, the third in the series, will provide even more clarity about the shape of post-pandemic supply chains and related SCS challenges and opportunities. And it will include innovative analytical approaches, such as the new sustainability typology in this edition that we believe will promote a better understanding of SCS decisions and motivations.

We hope you will join us on this journey and participate in the 2022 State of Supply Chain Sustainability effort.

ACKNOWLEDGMENTS

Sponsoring Organizations

Blue Yonder

C.H. Robinson

Intel

KPMG

Sam's Club

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ACKNOWLEDGMENTS

Sponsoring Companies Advisory Panel

Ella Chan, Sam's Club

Adam Schafer, Intel

Rachel Schwalbach, C.H. Robinson

James Sembrot, Sam's Club

Gretchen Hall, KPMG

Kristin Pedersen, KPMG

Jolene Peixoto, Blue Yonder

Additional Acknowledgments

Tevita A. Akau

Halide Alagoz

Laura Allegue

Ana Lucia Alonzo

Magali Anderson

Brittany Bama

Ashley Barrington

Sergio Barbarino

Ezgi Barcenas

Patrick Browne

Inma Borrella

David Correll

Katie Date

Chris Ettery

Jane Franch

Daniel Francois

Suzanne Greene

Toby Gooley

Jay Guo

Jim Hartzfield

Sheri Hinish

Yinjin Lee

Benny Mantin

Pamela Mar

James McCall

Michael Milam

Tyler Morgan

Radu Palamariu

Kris Oswold

Andrew Pastor

Ceclia Pecorari

Pranav Prakash

Eva Ponce

Jim Rice

Wendy Tate

Susana Val

Karen van Nederpelt

Kyra Whitten

Jennifer Wong

Hong Mo Yang

Organizations

Achieving Women's Excellence in Supply Chain Operations, Management, and Education (AWESOME)

Center for Latin-American Logistics Innovation

Luxembourg Centre for Logistics and Supply Chain Management

Malaysia Institute for Supply Chain Innovation

Network for Business Sustainability

Ningbo China Institute for Supply Chain Innovation

One Step Closer

Retail Industry Leaders Association

Supply Chain Brain

Supply Chain Management Review

Supply Chain Revolution

Zaragoza Logistics Center

MIT Center for Transportation & Logistics

MITx MicroMasters® Program in Supply Chain Management

Council of Supply Chain Management Professionals

GLOSSARY

Climate change mitigation: There is broad scientific consensus that increasing concentrations of greenhouse gases (GHG) in the earth's atmosphere are changing the climate. Climate change mitigation efforts seek to reduce the impacts from a changing climate by reducing emissions of and removing GHGs from the atmosphere on a global scale.

Community impact: Business strategies that have an impact on the communities in which they operate.

Corporate social responsibility (CSR): The commitment of firms to incorporate environmental, social, and governance responsibilities into their businesses and supply chains.

CSR/sustainability report: A periodic report published by companies in order to portray the relationships between a company and society and to communicate efforts the company is making to be sustainable.

Covid-19: The official name given by the World Health Organization to the disease caused by the novel coronavirus that first emerged in late 2019.

Disclosure: A company's sharing of information that informs its stakeholders about its activities to provide equal access to facts about the company. This may come in the form of press releases, sustainability reports, or other formats.

Employee welfare and safety: Services, facilities, and benefits provided by employers to create better and safer conditions for workers.

Engagement: An organization's efforts to understand and involve stakeholders in its activities and decisions.

Environmental sustainability: The collective practices that reduce the negative impact or increase the positive impact of firms on the environment, which may include natural resource and biodiversity conservation, climate change mitigation, water conservation, and others.

Fair trade: Practices that support greater equity in international trade.

Human rights protections: Protections against situations where persons are coerced to work through the use of violence or intimidation or by more subtle means, such as accumulated debt, retention of identity papers, or threats of denunciation to immigration authorities.

Greenwashing: When a firm releases unsubstantiated claims that aim to deceive consumers into believing that a company's products are more sustainable than those of its peers.

Investment in sustainability: Committing financial or human resources to achieving progress toward sustainability goals.

Natural resource/biodiversity conservation: The sustainable management of all resources in the environment which may include natural and animal resources.

NGO or third-party collaboration: Collaboration with a nongovernmental organization or third party to support sustainability efforts on a specific issue.

Regulatory due diligence: A comprehensive assessment of compliance with existing regulation related to social and environmental concerns.

Reporting: The collection and presentation of information about practices to a reporting organization which ensures compliance and tracks progress year over year.

Social sustainability: Ensuring positive social conditions for all individuals involved in the supply chain. This effort may include fair trade/fair pay programs, employee health and safety regulations, human rights protection, and other measures.

Stakeholders: People, groups, or organizations that have a direct or indirect stake in an enterprise because it can affect or be affected by the organization's actions, objectives, and policies.

Supplier audit: An annual, or more frequent, on-site examination to identify and assess social and environmental issues at suppliers' sites.

Supplier benchmarking: Evaluating and comparing suppliers based on their compliance with established sustainability standards.

Supplier code of conduct: A code of conduct for ensuring that a company's suppliers support environmentally responsible practices as well as safe and equitable labor conditions.

Supplier collaboration: Working with a supplier to scale its practices and determine improvements that can be made to increase sustainability.

Supplier diversity, equity, and inclusion: An organization's effort to support traditionally underrepresented or underserved groups in its supply chain.

Supplier training: Programs that teach suppliers' workforces and management teams practices that help improve their social and/or environmental compliance.

Supply chain management: All activities associated with managing the flow of goods and services from raw material to end of life.

Supply chain mapping: The process of collecting information from suppliers and other supply chain entities to document the sources of materials, processes, and flows involved in bringing products to the customer.

Supply chain sustainability: The management of environmental and social impacts within and across networks consisting of suppliers, manufacturers, distributors, and customers in line with the United Nations' Sustainable Development Goals.

Supply chain transparency: Cross-supply chain information sharing and public disclosure of activities and practices within a company's supply chain to parties outside of the company.

Sustainability goals: Objectives or commitments set by businesses related to their sustainability.

Sustainability standards and certifications: Voluntary, independently assessed production standards and certifications adopted by companies to demonstrate sustainable progress.

Third-party verification: The employment of an external party to verify internal claims about sustainability progress for public disclosure.

Traceability of materials: The ability to follow the movement of a material or good through the supply chain from raw material to final product.

Water conservation: The sustainable management of water resources.

APPENDIX A: DATA & METHODOLOGY

This section details the background and makeup of the two-year survey data set centered on industry professionals, executive interviews, and content analysis. The analytical framework answers a three-part question: Are there groupings that can explain differences in SCS measures, how have SCS practices changed from 2019 to 2020, and what is the impact of Covid-19 on SCS commitments? First, we describe the background and state of our survey data and provide an overview of data cleaning and segmentation processes. Next, we describe the imputation techniques used to address missing data. Finally, we introduce other analysis approaches such as k-means clustering for company types, correlated based groupings for practices clusters, ANOVA analysis, then conclude with interviews and content analysis.

Survey Data Framework

In 2019, the MIT Center of Transportation & Logistics (MIT CTL) in collaboration with the Council of Supply Chain Management Professionals (CSCMP) developed an annual research project to better understand SCS efforts and their evolution over time across multiple functions, industries, and geographies. The research is centered on a yearly anonymous survey sent to industry professionals. It asks them to describe their firms' level of engagement on a variety of key SCS topics and issues with a primary focus on goals and commitments, investments, pressure sources and disclosure practices. It also asks questions about the respondent and their firm.

Both the 2019 and 2020 surveys use the Qualtrics survey platform for data collection. The survey is designed with skip logic (SL) questions that automatically adjusts the survey path based on how questions are answered. SL increases the quality of responses by reducing redundant questions using already-known information. For example, if a respondent indicates their company does not do a particular activity, it will not ask specific questions about the nature of that activity.

The survey questions were developed after careful consideration of existing research on supply chain sustainability, input from supply chain experts at MIT CTL, CSCMP, and other organizations, and the growing corpus of corporate sustainability reports. The questions were then tested and validated by supply chain professionals to assess their effectiveness and usefulness in a real-world setting. For the 2020 survey, modifications to the question format, arrangement, and answer choices were made based on an analysis of the survey,[75] team experience, and feedback from external partners. Both the 2019 and 2020 surveys were conducted between October and November and advertised in multiple media outlets with a primary focus on network email lists and LinkedIn outreach.

Data Mapping

Given that the 2021 report survey is a direct evolution of the 2020 survey, there are similarities and differences that need to be identified to properly compare both years' results. The layout of both surveys is similar, and both include questions using a Likert scale (1–5 with greater intensity) and questions that are heavily categorical. As seen in **Table 3**, the 2019 survey data was mapped to 2020 data for comparison between the two years. If multiple answer choices were mapped to one answer, we used the average of the Likert responses. If a question was added or subtracted, such as the addition of questions specific to Covid-19, it was only analyzed within the context of that year.

Table 3: Survey question mapping.

Question	2019	2020
Q5_2_1, Q5_2_2	Air pollution mitigation, Natural resources and biodiversity conservation	Natural resource and biodiversity conservation
Q5_1	Carbon emissions reduction	Climate change mitigation
Q5_3	Energy management	Energy savings/renewable energy
Q5_4	Water management	Water conservation
Q5_5	Waste and end of life management	End of life management/supply chain circularity
Q5_6	Worker welfare & employment quality	Employee welfare & safety
Q5_7_1, Q5_7_2	No forced or slave labor , No child labor	Human rights protection
Q5_8	Impact on local communities	Local community impact
Q5_9	Supplier diversity & inclusion	Supplier diversity, equity, and inclusion
Q5_10	Fair trade/fair pay	Fair pay/fair trade
Q5_other	Other	Other

Changes were also made to some of the demographic questions. In the 2019 survey, we asked respondents to provide the country of their company headquarters, but for 2020, we asked for the continent. The 2020 survey also allowed individuals to select multiple locations. For comparative analysis, a single location was decided based on survey size for each continent.

Data Imputation

Missing data was present in a small percentage of survey responses. Not all respondents definitively answered all parent SL questions, and missing data was present when they selected "skip", "not sure", or "no" to the parent SL questions. This presents a problem for certain analyses that require complete data. As a result, we filled in or imputed missing values, when necessary, for analysis and based on the following classes:

- **Class 1:** For parent SL questions with an answer of "yes" but blank responses for child SL questions, we can reasonably conclude they intended to select "no" to the missing topics and so used a Likert scale choice of 1.
- **Class 2:** For parent SL questions with a definitive answer of "no", we directly imputed their corresponding child SL answers to "no" which corresponds to the lowest available Likert scale choice of 1.
- **Class 3:** For parent SL questions with an answer of "not sure" or "skip", it is much harder to determine the correct course of action for the missing data, as we do not have a clear indicator for how they would have responded.

Table 4 summarizes the imputations made depending on how individuals answered the parent SL questions and the type of analysis used.

Both surveys asked respondents to select the industry and department they are employed in, and in some instances, respondents chose to manually input their responses rather than select a predefined category.

Table 4: Parent-child SL imputation for clustering analysis.

Initial Parent SL Answer	Child SL Answer	Subsequent Imputation	Analysis Used
Yes	Filled in	None	All
Yes	Blank	(1 Likert) = "No"	Clustering and t-tests
No	Blank	(1 Likert) = "No"	Clustering
Not sure	Blank	Deleted	
Skipped	Blank	Deleted	

For analysis, we examined the manual entries and matched an existing category that fit the description.

Clustering

The descriptive results from the State of SCS survey often suggested that there are certain "types" of companies, and this classification may help explain some of the patterns we observe. To test this hypothesis, we used clustering models based on survey data from 2019 and 2020. We first ran an unlabeled clustering algorithm on these answer choices to determine whether there were patterns in the data without looking at the categorical labels.

Given the experimental nature of unlabeled clustering, we ran multiple scenarios using different sizes of clusters and imputation methods to optimize the method including:

- **Phase 1:** k-Nearest Neighbors (KNN) imputation for missing parameters and k-means clustering ($k = 3$ and 4) with each dataset separately
- **Phase 2:** KNN imputation for missing parameters and k-means ($k = 5$) on 2020 survey data then predicted cluster class for 2019 data
- **Phase 3:** Listwise deletion of missing parameters and k-means ($k = 6$) clustering on the combined 2019 and 2020 survey data

In Phase 1, k-means ($k = 3$) clustering was conducted on the child SL answers using the Likert scaled data from the 2019 and 2020 surveys separately. An outlier cluster was identified reflecting responses with missing data. After evaluation and analysis, we then re-ran clustering with a ($k = 4$) on the data set excluding an outlier cluster identified in Phase 1. In Phase 2, we trained k-means clustering with $k = 5$ on the 2020 dataset (excluding the Phase 1 outlier class) and then predicted the cluster class for the 2019 dataset (excluding the Phase 1 outlier class). Lastly, in Phase 3, we used listwise deletion—instead of the outlier class—removing the missing data and only clustering on complete responses. Although the sample size for Phase 3 was smaller, the results were very similar to those of the Phase 2 approach. Given the similarity in results, we decided to proceed with the Phase 3 approach. A scree plot confirmed that 6 was an appropriate number of groupings to use.
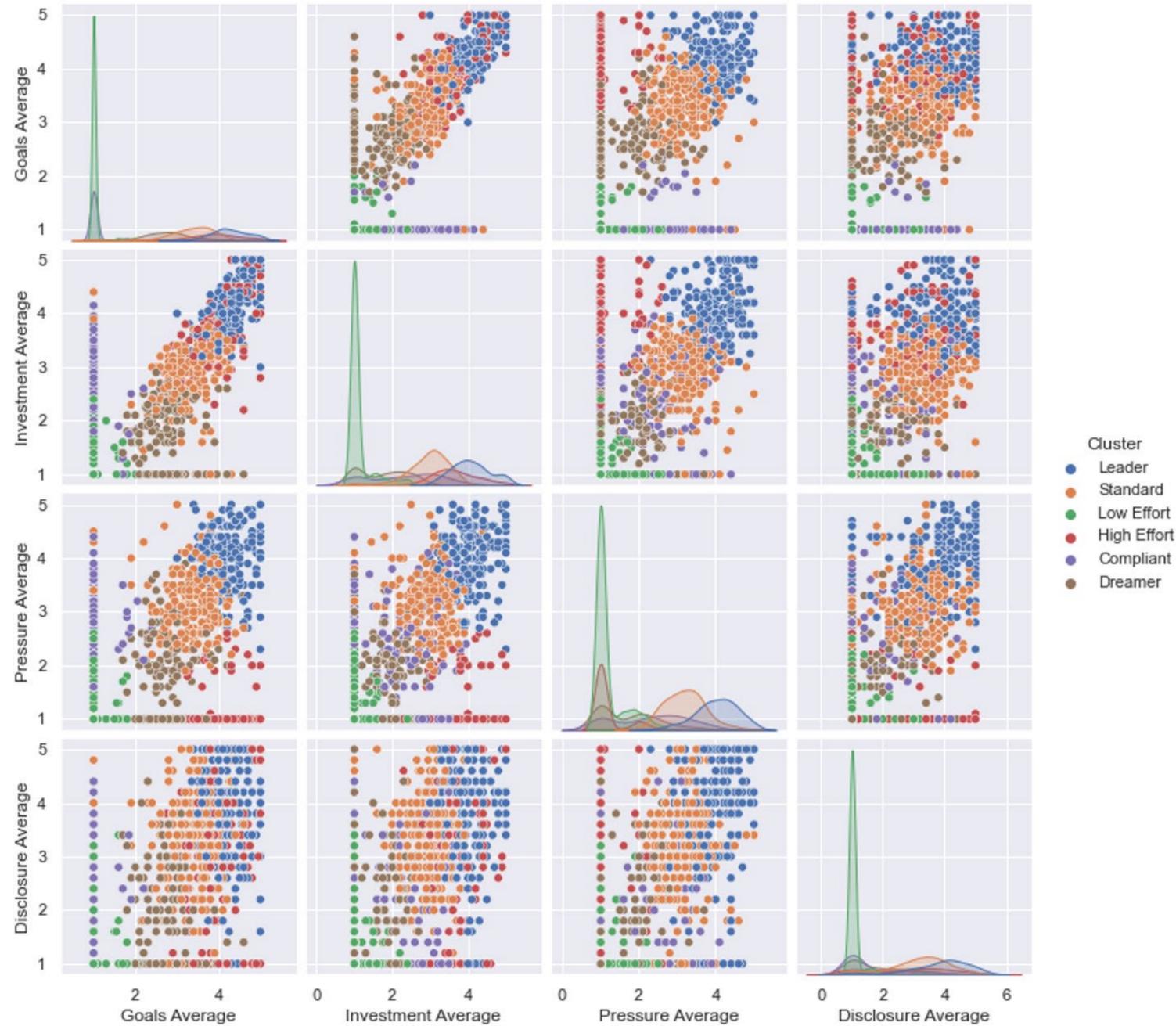
Figure 23: Graphical representation of the 6 clusters and how they formed across different the four main framework areas. N = 1,557.

	Topic	Leader	High Effort	Standard	Compliant	Dreamer	Low Effort
Goals	Climate change mitigation	4.11	3.72	3.57	2.55	2.70	1.72
	Energy savings/renewable energy	4.30	4.11	3.67	2.73	3.16	1.94
	Water conservation	4.04	3.70	2.98	1.27	2.75	1.44
	End of life management/supply chain circularity	4.06	3.57	3.12	1.64	2.73	1.50
	Natural resource & biodiversity conservation	3.97	3.55	2.92	1.45	2.23	1.47
	Employee welfare & safety	4.55	4.37	4.08	1.91	3.54	1.61
	Human rights protection	4.56	4.31	3.67	2.00	3.02	1.50
	Local community impact	4.47	4.26	3.59	1.82	2.87	1.50
	Supplier diversity, equity & inclusion	4.20	3.95	3.20	1.73	2.61	1.61
	Fair pay/fair trade	4.43	4.17	3.30	1.73	2.75	1.33
Investment	Climate change mitigation	4.02	3.60	3.25	2.56	2.18	1.72
	Energy savings/renewable energy	4.19	3.99	3.44	2.99	2.35	2.12
	Water conservation	3.95	3.52	2.69	2.27	2.05	1.60
	End of life management/supply chain circularity	4.01	3.42	2.88	2.37	2.12	1.68
	Natural resource & biodiversity conservation	3.94	3.36	2.60	2.25	1.70	1.37
	Employee welfare & safety	4.40	4.11	3.60	3.45	2.70	2.32
	Human rights protection	4.09	3.64	2.77	2.57	1.80	1.41
	Local community impact	4.13	3.82	3.12	2.93	2.16	1.98
	Supplier diversity, equity & inclusion	3.92	3.55	2.75	2.75	1.79	1.81
	Fair pay/fair trade	4.08	3.65	2.78	2.79	2.04	1.65
Pressure	End consumers	3.91	2.22	3.15	2.94	2.56	2.32
	Corporate buyers	3.73	1.67	3.05	2.97	2.23	1.99
	Investors	3.99	1.78	3.30	2.74	2.35	1.61
	Current and prospective employees	3.90	2.00	3.11	2.87	2.25	1.99
	Company executives	4.38	2.44	3.55	2.87	2.83	1.69
	NGOs and other third parties	4.00	1.59	3.18	2.55	1.83	1.57
	Industry associations	3.97	1.63	3.08	2.45	2.10	1.67
	Governments & international governing bodies	4.25	2.37	3.43	2.86	2.60	1.87
	Mass media	4.06	1.52	3.12	2.68	2.13	1.81
	Local communities	3.98	1.93	2.98	2.50	1.91	1.87
Disclosures	Website	4.48	3.86	4.23	3.29	3.25	2.34
	Press releases	4.22	3.37	3.87	2.69	2.72	1.58
	Reporting organization	3.60	2.80	2.72	1.95	1.81	1.66
	Company Sustainability/CSR report	4.16	3.37	3.61	2.48	2.70	1.71

Full results of the heatmap of the clustering typology behavior can be seen in **Table 5.**

Practice Groupings

For the practice groupings, our objective was to determine whether there are combinations of SCS practices that are likely to be used by companies. To do this, we used correlation-based grouping, which means that practice grouping was based on the correlation of survey responses reporting its use. We used Cramér's V

correlation coefficient, which is a measure of association between two categorical variables.

To do this, we first computed the correlations between all the practices and created a practices-correlation matrix. Then, we applied a threshold, such that all entries with correlation greater than the threshold are set to 1 and the rest to 0. This new matrix can be viewed as the adjacency matrix for a graph, where each node corresponds to a practice, and an edge between two nodes is present only if they are sufficiently correlated. The grouping is done by collecting the connected components of this graph into different groups. This analysis was implemented using the *NetworkX* library in Python.

Descriptive Analysis

To better understand the current state of supply chain sustainability and help quantify what changed from the prior year, we conducted a descriptive analysis and summary of the survey results using data visualizations. This approach also allowed us to use data with missing parameters.

We tested Class 1 and Class 2 imputations in our visualizations. Given the skewed nature of the Class 2 results and a desire to match last year's report we ultimately settled on hybrid approach (see **Table 6**).

Table 6: Parent-child SL imputation for descriptive analysis

Initial Parent SL Answer	Child SL Answer	Subsequent Imputation
Yes	Filled in	None
Yes	Blank	(1 Likert) = "No"
No	Blank	Blank
Not sure	Blank	Blank
Skipped	Blank	Blank

The visualizations kept the Class 1 imputation, which fill the blank child responses with "no" if the parent response was initially "yes" and left the remaining answers blank matching last year's visualizations.

Goals vs. Investment Statistical Analysis

To better understand the goals vs. investment alignment statistical analysis, we conducted a descriptive analysis, which consisted of plotting the alignment and conducting hypothesis testing using the Wilcoxon rank test to determine if the difference between goals and investment (in each focus area) is statistically significant. Hypothesis testing using the Wilcoxon rank test to determine if the difference between goals and investment has changed between the two years.

Non-Parametric Analysis of Covid-19 Questions

In the 2020 survey, a new group of questions related to Covid-19 were added, including a section asking respondents whether their firm's commitments to supply chain sustainably has changed due to pandemic. We then tested the hypothesis that some industries will reduce sustainability commitments with an analysis of variance (ANOVA).

With the industry groups set as the independent variable, we used the Kruskal-Wallis test (one-way ANOVA on ranks) to identify whether there are statistically significant differences among these industry groups and their Covid-19 commitment.

To analyze changes with other SCS measures between 2019 and 2020, we ran multiple nonparametric independent sample *t*-tests (Mann–Whitney *U* tests). These tests compared changes the 2019 and 2020 surveys goals, disclosures, pressure, and investments measures.

Regression Analysis for Pressure Sources

To understand the effect of pressure sources on commitments, we modeled the level of commitment in each area focus area as a function of the level of pressure received. Since we are working with Likert scale data, we used an ordinal logistic regression model. Elastic net regularization was used for variable selection.

Issue Area	Pressure sources with statistically significant regression coefficients for goal-setting (by focus area)					
	Pressure Source 1	Reg. Coef	P-value	Pressure Source 2	Reg. Coef	P-value
Climate change mitigation	Company Executives	0.391082	9.62E-06	Industry associations	0.223431	0.018096
Energy savings/Renewable energy	Company Executives	0.466942	3.16E-08	Industry associations	0.146421	1.39E-01
Water Conservation	Company Executives	0.346533	8.64E-06	Industry associations	0.225803	0.028795
End of life management/sc circularity	Company Executives	0.366185	1.97E-06	Industry associations	0.190442	0.063243
Natural resource/Biodiversity conservation	Company Executives	0.392356	2.94E-07	Industry associations	0.203357	0.035768
Employee welfare & safety	Company Executives	0.3982	6.32E-06	Industry associations	0.138509	0.152831
Human rights protection	Company Executives	0.456177	4.23E-07	Industry associations	0.140619	0.174992
Local community impact	Company Executives	0.362146	4.01E-05	Local Communities	0.3033	0.001292
Supplier Diversity, equity, inclusion	Company Executives	0.350602	0.000121	Local Communities	0.145826	0.098092
Fair pay/ Fair Trade	Company Executives	0.390435	1.10E-06	Industry associations	0.165633	0.084299

For each target variable (for commitment level in each focus area), we first perform ordinal logistic regression with an elastic net penalty, using all the pressure sources as regressors. This is the variable selection step, after which we choose only those pressure sources which have nonzero coefficients. We then run the regression on the commitment level using only the hosen subset of pressure sources as regressors and report the coefficients and their corresponding *p*-values.

Qualitative and Content Analysis

Industry	Percent
Consulting	6%
Life sciences	6%
Technology	25%
Other	6%
Manufacturing	38%
Transportation & warehousing	19%
Total	100%

Executive Interviews

Twenty executives were selectively sampled based on an existing network to represent a range of industries (see **Table 8**). Each executive was asked the same set of questions via phone/web interview or email, and the questions were shared in advance of the interview. The interviews were analyzed for (1) key insights that either supported or contrasted the survey and content analysis findings; and (2) themes that emerged across the interviews. Questions included the range of content as covered in the survey inclusive of pressure, commitment, investment, disclosure, Covid-19, practices, and future outlook.

Sample interview questions:

- How important is SCS in your industry? How might this change in this 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?

Published Content

To complement learnings from the survey and executive interviews, we reviewed an extensive selection of relevant documents. Over the course of 2019 and 2020, more than 300 documents were reviewed, including 75+ corporate social responsibility and sustainability reports, 100+ news articles, 75+ journal articles and research reports, and 25+ industry reports. News sources and relevant journal articles were collected

using key phrases related to our research, such as "carbon emissions", "supply chain management", "sustainability", and "child labor", to identify relevant documents in aggregate news sources such as Factiva

were removed. The treemap diagrams are a plot of the relative word frequency within the articles A treemap diagram illustrating word frequency when searching for "supply chain" articles can be seen in **Figure 24**.
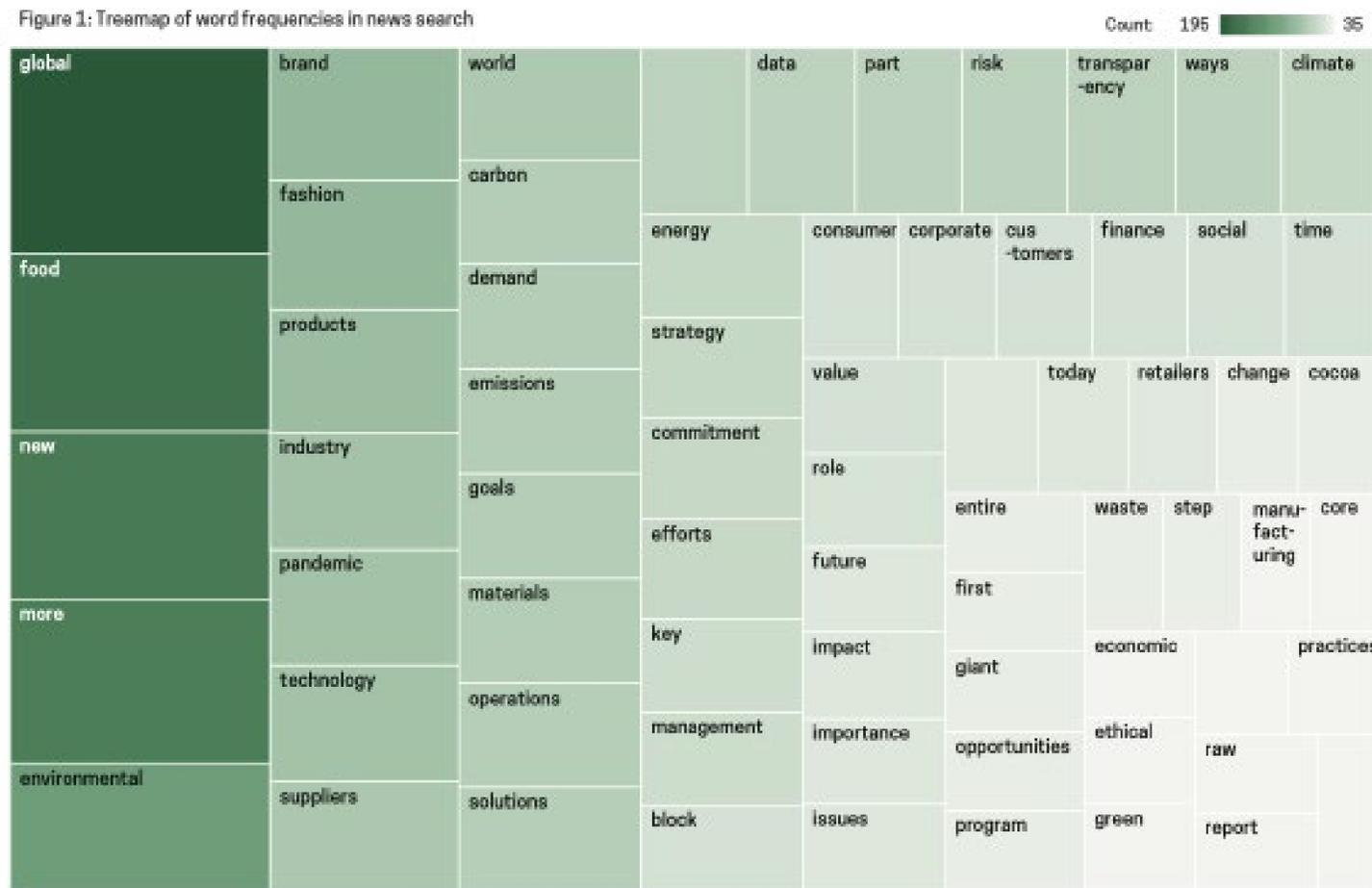

Figure 24: A treemap diagram illustrating the frequency of words found in the top 400 articles extracted from Google News when searching "supply chain" in 2020. N = 400.

and Google News. A representative sample of industry CSR reports were selectively sampled. Industry reports were reviewed from key universities, organizations, and industry associations in the field. The content was organized into a timeline, based on relevance to the different survey metrics, and visualized as treemap diagram. The treemap diagrams were created using 400 news articles published in 2020. Articles were identified using Google News search with the top 400 articles extracted based on the Google News search relevance setting. Noun and adjective words were extracted from the title and text snippet Google News generates for each article. The search term, and misclassified or filler words (e.g., "such" and "other")

APPENDIX B: LIMITATIONS

This section will detail the general limitations of our analysis and the key issues we encountered in our data cleaning process.

Responder Bias & Self-Selection Responses

A limitation of survey responses is that in some cases survey respondents will respond in the way that they assume to be desirable. This means that the data can skew in a more positive direction than is actual because of this responder bias.

In addition, the sample of responses may lean toward respondents who are more involved with sustainability given their ability to fully answer the questions. This may result in more positive results, representing the inputs of individuals who are involved in sustainability and not representing those who are less involved.

The anonymity of the survey helps reduce the impacts of responder bias and self-selection by removing attribution. There is less pressure by a responder to report positively, as there is no personal benefit.

Survey Representation

The data used in our analysis comes from anonymous surveys sent out to professionals across the world. In this approach, we assume the individual responses are representative of their parent firm or company. Given that we were not able to collect actual business information such as company name, our analysis is inferring these characteristics based on the information respondents are answering on behalf of their firms. Anonymous information was solicited to be able to derive unbiased reporting from respondents on what their firms are doing in the SCS environment.

Missing Data

As mentioned in the data-cleaning process, missing data was present in our survey as a result of the skip-logic survey design. When respondents chose to skip or select not sure or no to certain parent questions, responses were left blank for the related child questions. We would ideally keep all the survey data and analyze our information as is. However, given the amount of missing data, we opted to use a listwise deletion. For the remaining missing parameters, we then used imputation techniques based on our analytical needs.

Manual Entries

Questions regarding company headquarters location, department affiliation, and industry type allowed respondents to manually enter an answer. To include this data in our analysis, a decision had to made to recategorize these entries into a parent category. Given the ambiguity of some manual entries a best guess effort was made that may not be fully representative of the intent of the original response.

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