Lehigh Business Supply Chain Risk Management Index

Quarterly Report

4th Quarter / 2023

LEHIGH UNIVERSITY | College of Business

CENTER FOR SUPPLY CHAIN RESEARCH AT LEHIGH

CSCMP Council of Supply Chain Management Professionals

Educating and Connecting the World's Supply Chain Professionals.™

LEHIGH BUSINESS SUPPLY CHAIN RISK MANAGEMENT INDEX

Welcome to the **Lehigh Business Supply Chain Risk Management Index Report** developed by the Center for Supply Chain Research at Lehigh University and the Council of Supply Chain Management Professionals.

We launched this index in August of 2020 to better understand the different kinds of supply chain risks businesses face. **Supply chain professionals rated the likelihood that the risk in the 4th Quarter of 2023 compared to the risk in the 3rd Quarter of 2023 would likely increase, remain the same or decrease for 10 different Supply Chain categories.**

The Lehigh Business Supply Chain Risk Management Index (LRMI) value is a number between 0 – 100, where greater than 50 suggests increased risk, equal to 50 suggests the same risk and less than 50 suggests decreased risk. **The average LRMI for the 4th Quarter is 65.10 which is a decrease from the 3rd quarter, suggesting a lower level of risk in the 4th Quarter 2023.**

The table below reflects the 10 categories of risk from highest risk to lowest risk when evaluated independently as perceived by supply chain professionals.

If you would like to have additional information about the survey or to participate in the survey, please contact Dr. Zach G. Zacharia at zacharia@lehigh.edu.

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Executive Summary

Cybersecurity is again the highest risk overall at 75.34, but this is a drop of 7.5 points compared to last quarter, suggesting cyber-attacks, data corruption, data theft, system viruses, and security platform controls are serious risks, but this risk is decreasing. Economic risk is again 2nd overall, and again, there has been a decrease in risk to 71.92, suggesting the economy still remains a significant risk in the 4th Quarter. The following two risks have switched in order from the 3rd Quarter, so Government Intervention Risk has increased to 71.92 while Customer Risk has dropped to 67.12. Interestingly, Supplier Risk has become a top 5 risk, suggesting single-source suppliers, supplier quality, and price issues are becoming more problematic for supply chain managers going forward. The average risk index has decreased slightly to 65.10, which is still low compared to the average risk historically.

Risk Type	3rd Quarter 2023 Risk Index	4th Quarter 2023 Risk Index	Trend
Cybersecurity and Data Risk	82.86	75.34	↓
Economic Risk	75.96	71.92	↓
Government Intervention Risk	70.19	71.92	↑
Customer Risk	72.86	67.12	↓
Supplier Risk	60.95	65.75	↑
Transportation Disruption Risk	57.08	63.51	↑
Technological or Competitive Risk	60.00	62.33	↑
Environmental Risk	62.02	61.64	↓
Quality Risk	54.25	56.76	↑
Operational Risk	55.66	54.69	↓
Average Risk Index	65.18	65.10	↓

The Risk Index is a number between 0 – 100.
The further the number is from 50 the greater the level of risk.
The arrow indicates whether the risk is increasing or decreasing in comparison to the previous quarter.

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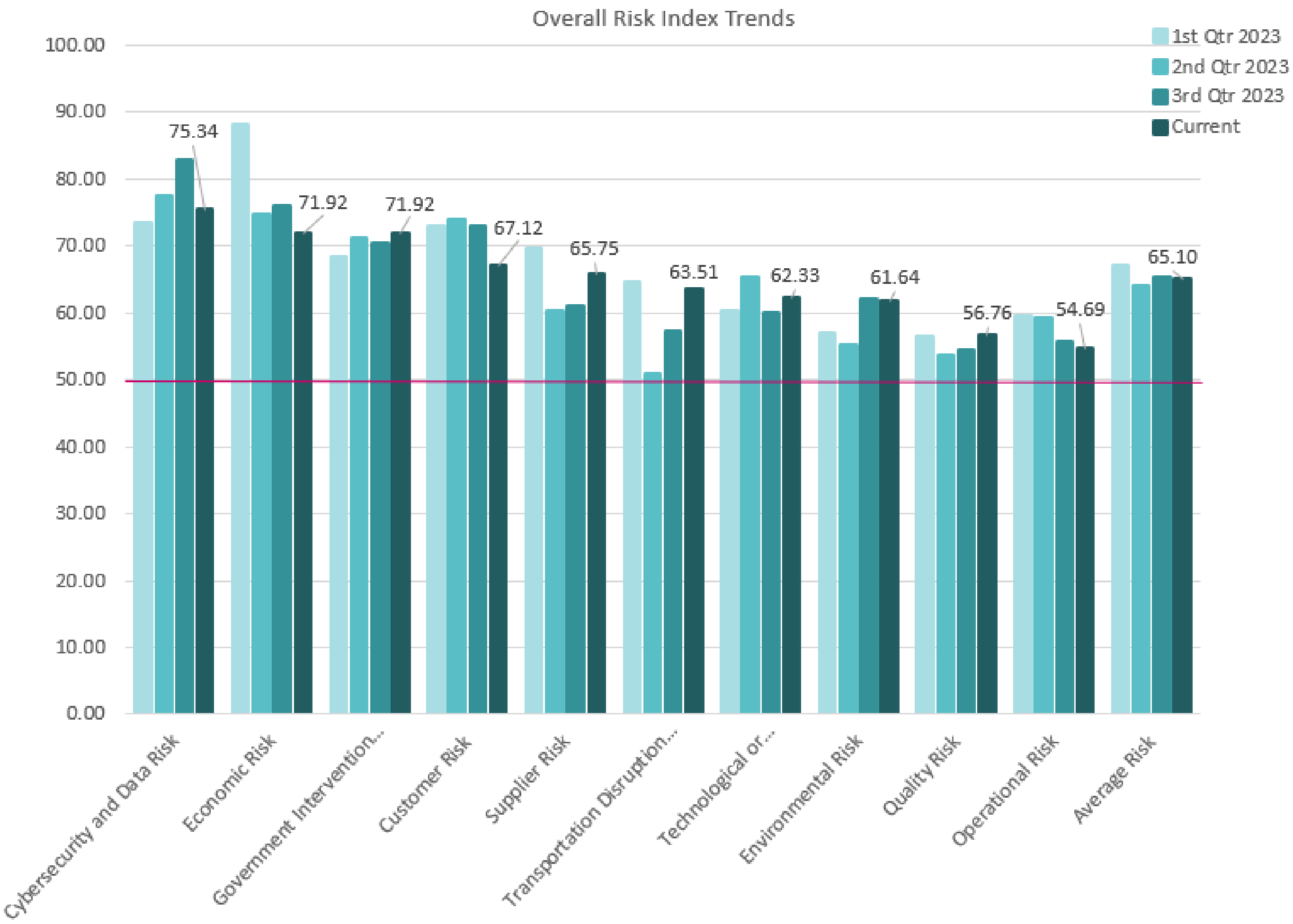
Did You Know?

The Lehigh Business Supply Chain Management Risk Index for the 4th Quarter in 2023 is

65.10

LRMI Risk Index Over the Last Year

One of the advantages of examining supply chain risk is to consider how these risks change over time. The table below shows the changing levels of the risk across the 10 different areas of the supply chain this last year. It is also insightful to see that some areas of the supply chain are consistently seen as high risk and other areas of the supply chain as lower risk over the same 1-year time period.



Four Biggest Risks in Head-to-Head Comparison 4th Quarter 2023

(Respondents are asked to compare across all 10 risks simultaneously, instead of rating one risk at a time.)

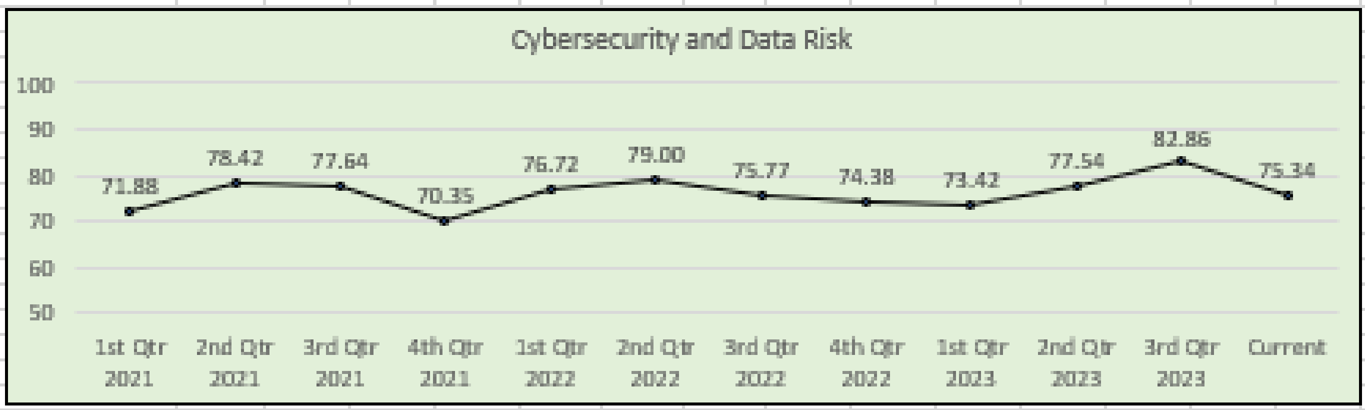
1. Economic Risk
2. Cybersecurity and Data Risk
3. Government Intervention Risk
4. Customer Risk

01 Cybersecurity and Data Risk

Some examples are: cyber-attacks, data corruption, data theft, system viruses, hardware and software issues and security platform controls.

Selected Comments:

- Cyber is a major dimension of warfare.
- AI is another disruptor being used by the bad guys to hack and threaten ransom, both in business and personal security.
- There are unpredictable linkages between compromised data centers.
- Cybersecurity attacks have been on the rise, both the quantity and types of attacks. It's a business; it's organized and strategic.
- Cybersecurity attacks on our vendors have been drastically increasing in the past 6 months and we expect this trend to continue for the foreseeable future.
- Unfortunately, the industry will see more of this. Much of what already happens is underreported for obvious reasons.
- Russian war in Ukraine and new PRK / Chinese partnerships increase cyber risk.
- Our long-time IT Director passed away last month. His successor will need some time getting up to speed, which could jeopardize our cyber security. I don't see any particular threats on the cyber front for ports/maritime as a whole.
- Notable increase in cargo theft, ransomed loads and double-brokering scams. Segment is largely dry van truckload shipments. Heavy use of electronic load-boards, stolen email contacts, similar email id scams, and stolen load/broker data.
- Absorbing a catalogue of new customers; they pose a channel for cyber threats.
- Reference Verizon's DBIR annual reporting for added, very in depth insights on this. DBIR = Data Breach Investigation Report. The latest edition can be found **here.**
- We’ve adopted new equipment and layers of protection in the last 12 months.

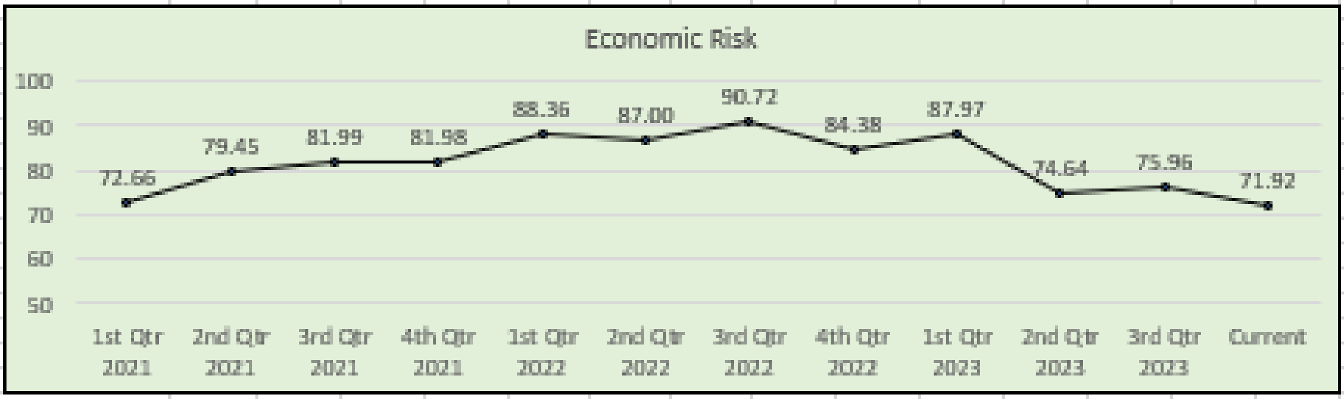


02 Economic Risk

Some examples are: increasing energy costs, commodity price volatility, labor shortages, sudden demand shocks, global energy shortages and border delays.

Selected Comments:

- Why would anyone work for any US business that doesn't pay them more than six figures? Any less is untenable in the long term. No one wants to work to enrich the "management class" or their owners.
- Inflation, Interest rates.
- Stock market down. Fitch downgrading of US Treasury market. US Dollar versus other world currencies. Slowing world economies, especially China.
- All the above.... we are entering into volatile times.
- Slight increase due to expected government intervention. Demand won't increase unless the Biden administration steps in.
- People and businesses will continue to get squeezed.
- An expected downturn in the economy is on the horizon.
- At some point, the higher interest rates will impact the economy. It is surprising that they haven't had more of an impact already.
- If we are not already in a recession, one will arrive soon.
- Economic risk is directly tied to consumer sentiment.
- Increasing energy costs are the primary concern.
- There is plenty of volatility in this area, but we specialize in alternative energy, so this risk should remain neutral for us.
- We are watching inflation via CPI/ECI closely, as well as Fed actions and, per previous, UAW negotiations.

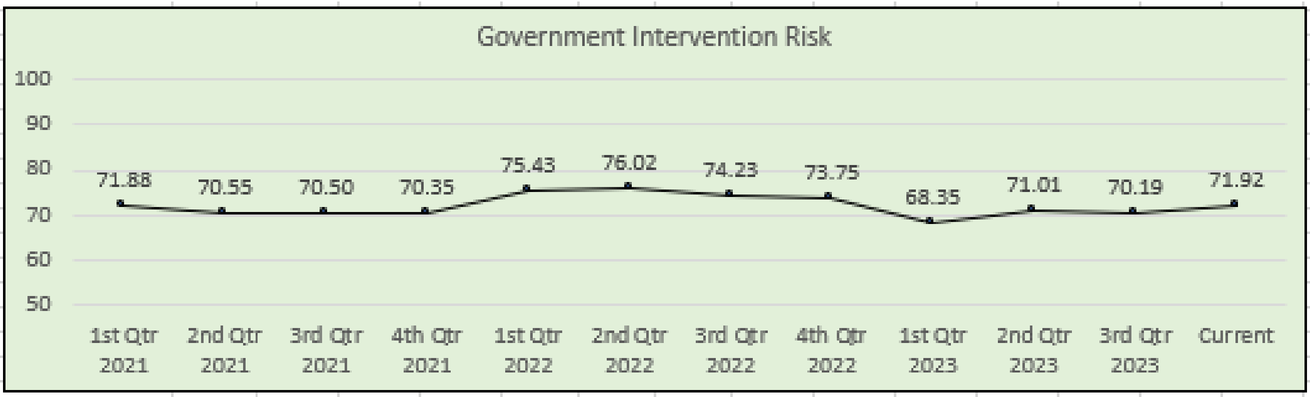


03 Government Intervention Risk

Some examples are: new regulations, tariffs/trade wars and governmental restrictions on source material, methodologies or technologies.

Selected Comments:

- The current administration over-regulates; risk will increase as long as they are in place.
- The latest polls say it will be Trump vs. Biden again in 2024. Until real leaders can emerge, our government power grabs will continue, and the effects of war and geopolitics will be harsh for US businesses.
- The war in Ukraine. Alliances between the US, South Korea and Japan. The weakening economy in China.
- Every week we are faced with different US states rolling out new "Chemicals of Concern" and putting legislation in place to control the sale of products that contain any of these chemicals in the raw materials / finished products. There is a huge risk that Government does not understand the impact to the Healthcare Sector.
- The Biden administration may begin to put policies in place that will spur the economy in 2024 as we head into an election year.
- Governments in collapse, at war, or otherwise not serving their people continue to present often unknown risks to supply chains, especially as those supply chains increase in scope across the world.
- Seeing increased risk due to US-China chip wars. Non-approval of Intel-Tower merger showing China is willing to take action against US tech companies, who are moving supply chain out of China to other geos. Threat of potential Chinese invasion of Taiwan increases overall risk to the technology supply chain.
- California CARB legislation, other states/federal environmental motor carrier and railroad legislation limiting efficiency and value for consumers. Higher capital and variable costs, which will be passed along through the supply chain...continuing inflationary pressure.

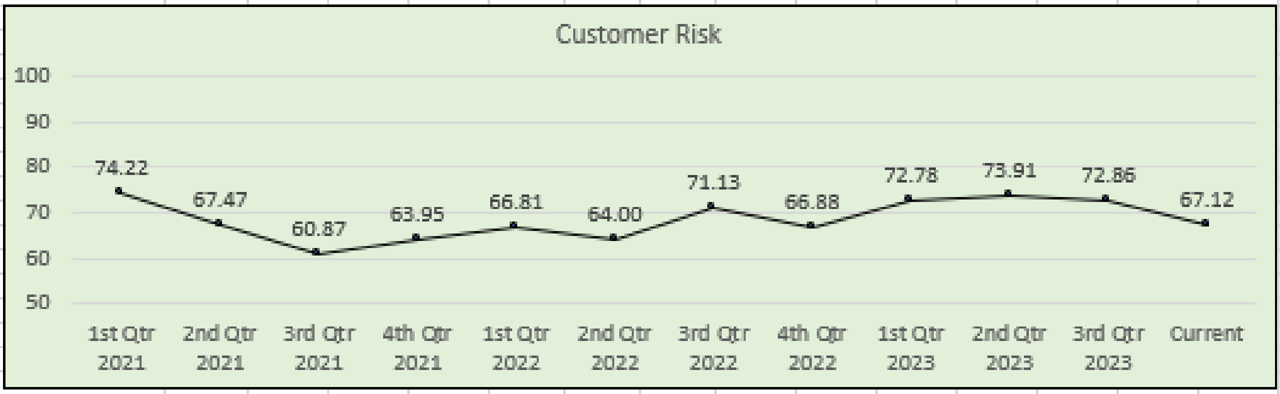


04 Customer Risk

Some examples are: fast changing customer demand, easy to lose customer loyalty, changing customer base demographics, hard to predict customer behavior and hard to service customer.

Selected Comments:

- Inflation, while supposedly ebbing, is still higher than targets; buying power has lessened, and consumer credit is at an all-time high.
- Impact of higher interest rates on credit cards purchases. Impact of higher mortgage rates on real estate related purchases.
- In 2023-2024 we should anticipate a further tightening in demand and inventory planning with so much economic uncertainty.
- As our customers face increasing prices, there is more risk that they will move business based upon price alone. Depending on our competitors' sales strategy, it's possible that they will cut price to win business volume. While this would be difficult for any company to execute, it is, nevertheless, a strategy to increase volume.
- Trading down to cheaper items such as private label.
- Fluctuating inventory levels due to sporadic consumer behavior will create challenges.
- At the moment, procurement teams have the upper hand so, for now, customer risk is high. Once freight rates rise, operations teams will dictate and customer risk will lessen.
- Customers are looking to save freight and logistics costs, leading to disruption.
- Consumer sentiment is a roller coaster right now.
- We always have super aggressive KPIs to improve service levels for customers, which alone would make me believe the risk would stay the same. However, couple that with a feeling of economic uncertainty heading into an election season, and this leads me to believe that there will be an increased risk in this area.
- For the most part, we retain trusted long-term partnerships, while we forge and earn trust with new ones.

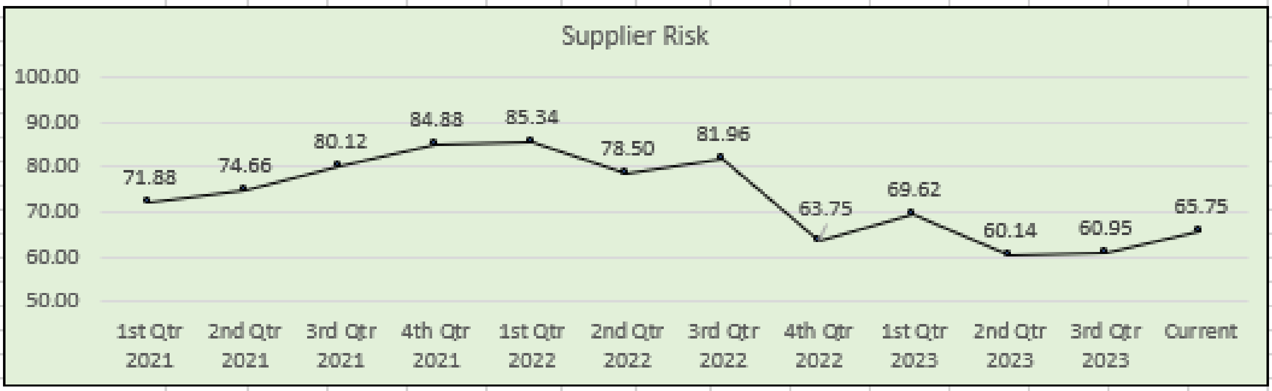


05 Supplier Risk

Some examples are: single/sole source supplier, suppliers from one geographic location, supplier quality issues, and price volatility.

Selected Comments:

- Companies like ours that decided to resource locally/regionally/nationally will be fine. Other companies that sought to deny reality wont be in a good place.
- Semiconductor supply is getting better. Alternatives are being proposed to lithium batteries for automotive.
- As we continue to standardize on a global basis, there seems to be little internal concern for the risk associated with developing new sole source strategic relationships globally for raw materials/commodities which are required to produce our product. The global landscape has proven to be unstable, and I believe this trend will continue.
- Reshoring has been key.
- The cost of materials has risen because of inflation; it has not yet abated. Additionally, credit terms tightening.
- Devaluation of currency is creating shortages and driving up prices.
- Contract manufacturing has really taken hold lately with domestic outsourcing to manufacturers with higher asset utilization to provide relief from asset and labor management. This loss of control makes it challenging to adapt to volume variability in non-company owned manufacturing facilities.
- Since COVID, supply chains are almost back to manageable levels. They're still not what they were in 2019, but they have improved.
- Delivery schedules are inconsistent and unpredictable.
- We're seeing increased diversity in suppliers.
- More suppliers will be onboarded to mitigate the risk of parts shortages. As stated previously, there will be quality risks, but supplier risk will be constant.

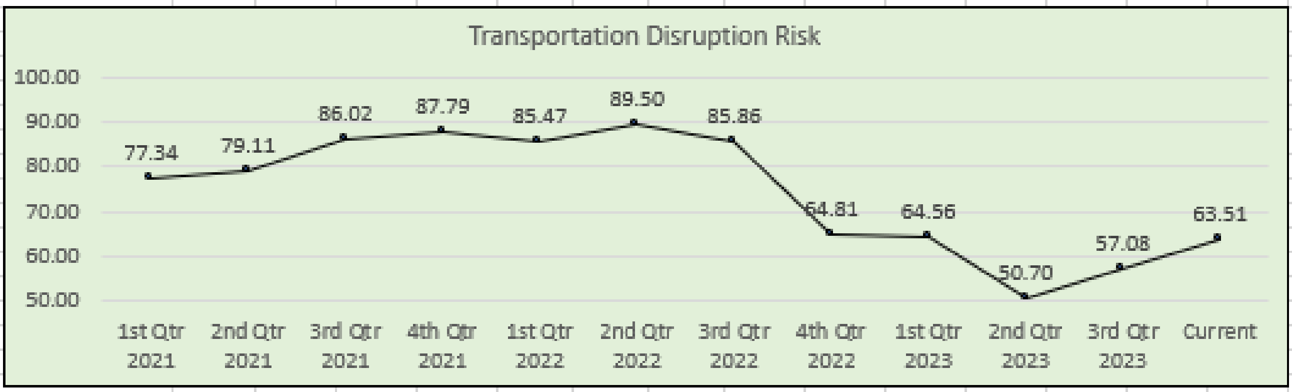


06 Transportation Disruption Risk

Some examples are: fuel prices, driver shortage, infrastructure and demand volatility.

Selected Comments:

- The UPS strike, while apparently settling, may prompt more of the same action in other companies. Airline staffing of pilots and other line personnel remains below needs.
- The Yellow bankruptcy will result in LTL price increases and the new UPS contract will have major cost impacts on small package shipping.
- I expect logistic pressure to expand into Q4; this will be driven by the continued surge in oil prices, along with the capacity constraints with the overall holiday demand.
- Overcapacity in ocean freight. Yellow Trucking bankruptcy.
- We are waiting to see how much impact the Yellow freight bankruptcy will have on costs. Costs and availability are still a problem.
- Again, we are beginning to see soaring fuel prices. With the decision to stop all domestic drilling there is no line of sight for pricing to ease, which continues to impact businesses.
- As freight rates rise, we will see a more challenging driver hiring environment.
- Diesel prices are again on the rise. Consumers are already hard-pressed by government inflationary policies, and have little room for credit or cost savings.
- There has been a notable increase in cargo theft, ransomed loads and double-brokering scams. Segment is largely dry van truckload shipments.
- Pete Buttigieg and this regime are not focused on maintaining infrastructure.
- The water level crisis in the Panama Canal may have a significant effect on transportation.
- Projecting continued improvement in spot market with balancing of capacity vs rates.
- We are seeing much improved transportation cost and capacity availability.

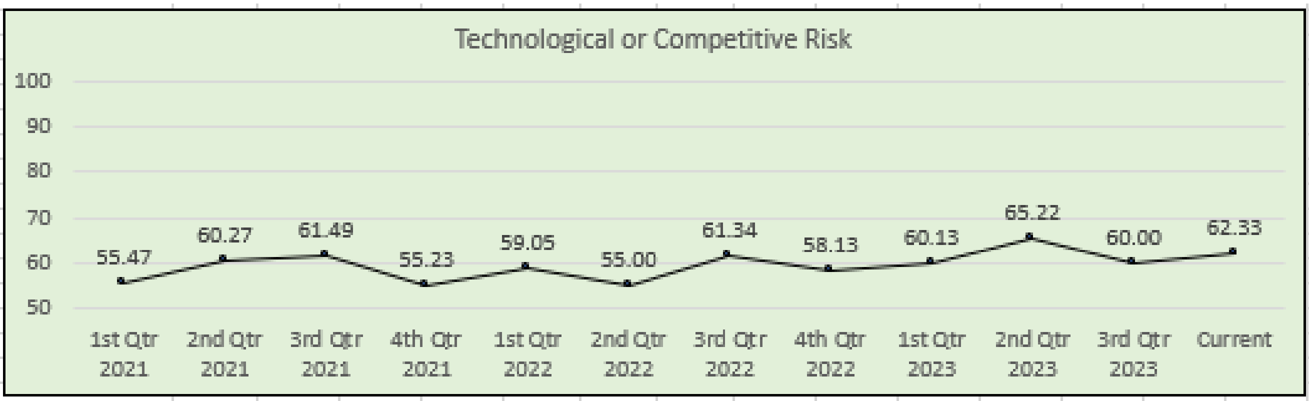


07 Technological or Competitive Risk

Some examples are: disruptive or replacement technologies, introduction of new competitor firms and ineffective or non-existent regulation for competitors.

Selected Comments:

- The gross institutions like Amazon, Google, Meta, etc. will continue to extract value from society and displace real, sustainable businesses.
- AI is being viewed as disruptive. Increased impact of misinformation. Major shits in social media platforms.
- Jobs will change as AI and related technologies continue to improve and become faster. The more reliant humans are on letting AI do the learning, the more stupid and lazy we'll become.
- Possibly a SLIGHT increase.
- We will remain the leader and welcome more competition. Q4 will be enough time to understand if the larger auto makers and energy entities will capitalize and gain ground.
- We ensure continual assessment of our technology-based resources to ensure they are proactive and suitable to our mission.
- Companies seem to be waking up post-pandemic.

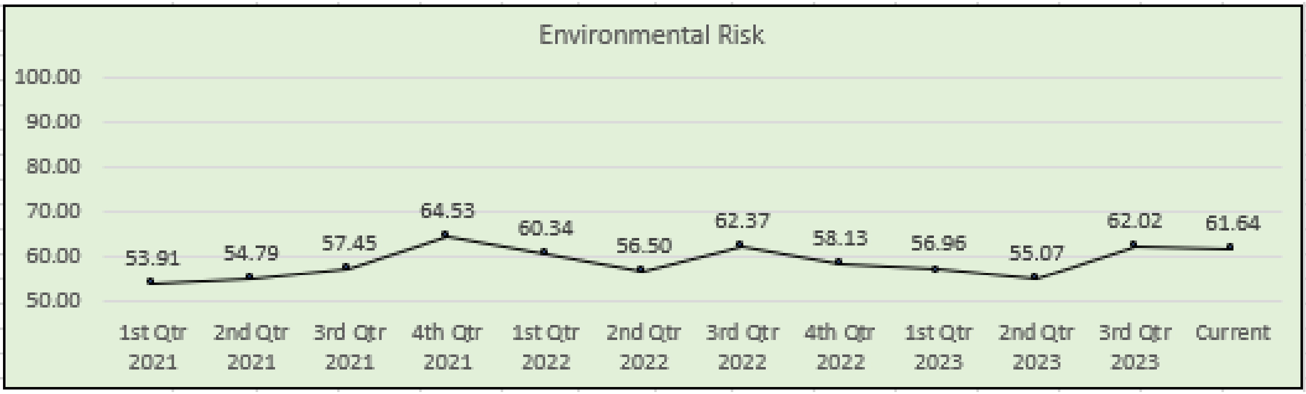


08 Environmental Risk

Some examples are: natural disasters, extreme weather, industrial accidents and pandemics.

Selected Comments:

- These risks are very much present and likely to increase.
- Projecting an uptick in bad weather, mainly snow, in Q4.
- The climate is changing and that should always be taken into account. Climate alarmism, however, is much worse than the actual problem. Darwin is on full display nowadays.
- Same as government regulations - largely associated with environmental impacts.
- We are seeing significant unusual weather in core markets (Florida, Texas).
- Environmental risk will remain about par for history, but those who decry "climate change emergency" deserve all the stress, loss of respect and power, and financial loss that will come their way. Conversely, real leaders are figuring out how to adapt and overcome.
- Environmental factors are overblown and not realistic.
- There is heightening awareness about polluted water and soils, dump site leakage, and rising water tables, along with an increased demand to get it all cleaned up.
- Our logistics centers and offices are located, for the most part, in low-risk areas.
- Projecting hurricane and storm risk in Q4.

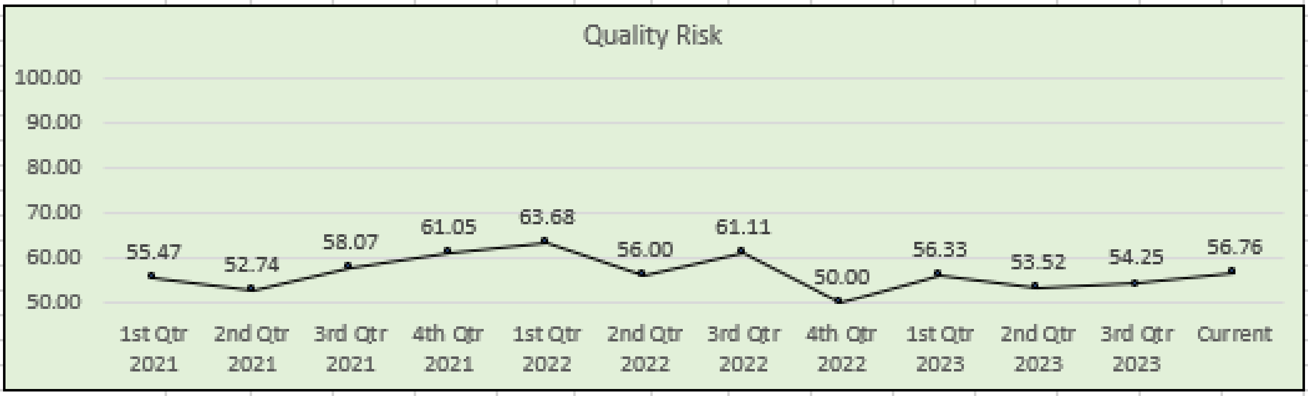


09 Quality Risk

Some examples are: lack of sufficient quality testing, changing quality standards, informal quality control documentation, customer safety issues and product recalls.

Selected Comments:

- High turnover in the workforce in the Lehigh Valley makes quality a significant risk at times.
- The lack of trained, knowledgeable workers will lead to quality/reliability problems.
- Capacity constraints on some pharmaceuticals.
- We have onboarded new suppliers.
- More vehicles and vehicle refreshes (updated parts) creates more opportunities to experience quality defects; defects per thousand opportunities (DPTO) is the associated metric. More so, new vendors being onboarded for new products (Cybertruck, Semi, etc.) will also be a factor in Q4.
- Don't buy from enemy nations, or your quality risk will increase. This is basic common sense.
- New brand quality standards are below ours, and we will need to work with vendor quality teams to improve packaging, labeling, and data provided.
- Our processes are tight; any quality risks derive from supplier/customer related factors.

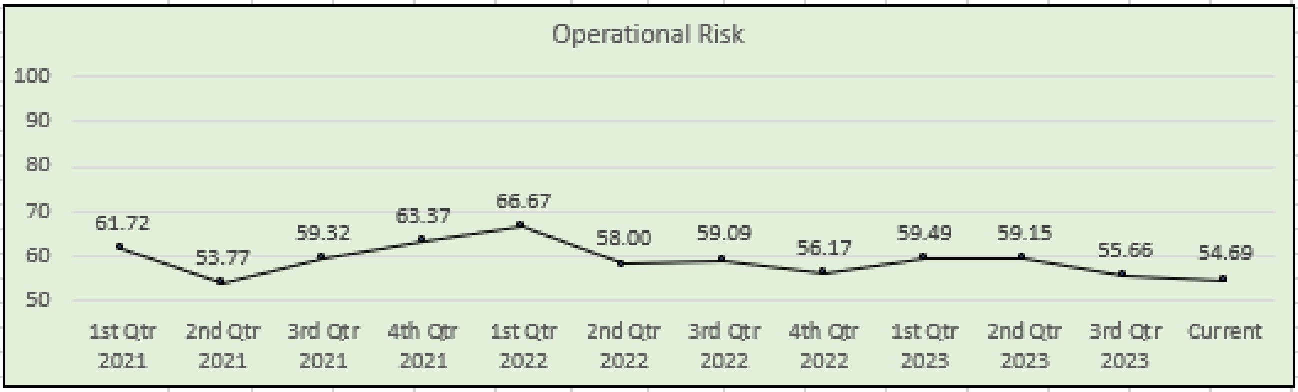


10 Operational Risk

Some examples are: site disasters, product counterfeiting, damage or disruption to physical assets and machine breakdown.

Selected Comments:

- Capacity management with higher demand.
- Summer heat leads to more breakdowns. This should decrease in autumn.
- COVID resurgence potential exists. Business are all facing cost pressure on Total Cost. In order to manage increasing costs and remain competitive, companies are going to need to make hard decisions on the business strategy and path forward. How do they respond to the rising costs? Reduce workforce? Increase pricing? Other cost cutting measures?
- It seems as if land, buildings and other essential producing assets are being bought by non-US entities. It's in-house outsourcing if you ask me.
- Inflation and increased taxation are having a detrimental effect on us and our customers.
- With the weak economic outlook, declining volumes make operational risk a larger factor.
- Slight risk due to supply chain on parts for repair if it were to occur.
- Storms and wildfires are putting distribution centers and the ability to operate at risk and this will likely continue into Q4. Additionally, the inability to sustain output due to the associated risk complicates the customer experience.
- Remains the same unless UAW strikes, which would pose a significant risk. Impact goes well beyond OEMs.
- Expansion of our facilities, and the acquisition of a new company.
- Improved processes and protocols have been set in place to prevent or mitigate potential disruptions.



Appendix A
Risk Index Summary

The Risk Index is a number between 0 – 100.

Risk Index ≤ 49 suggests less risk

Risk Index = 50 indicates no change in risk

Risk Index ≥ 51 suggests greater risk

The further the number is from 50 greater the level of risk.

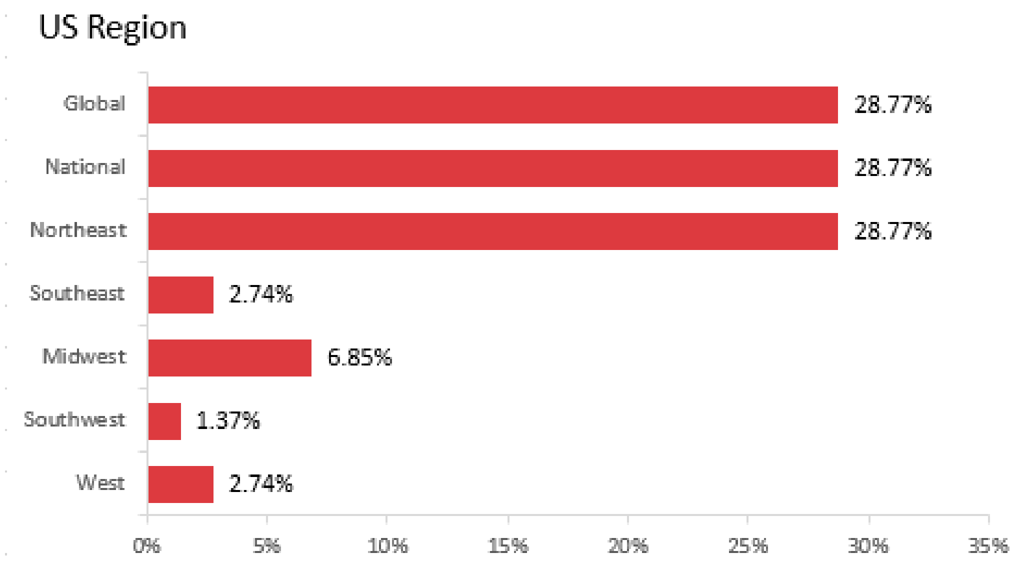
LBRI = (P1 * 1) + (P2 * 0.5) + (P3 * 0)

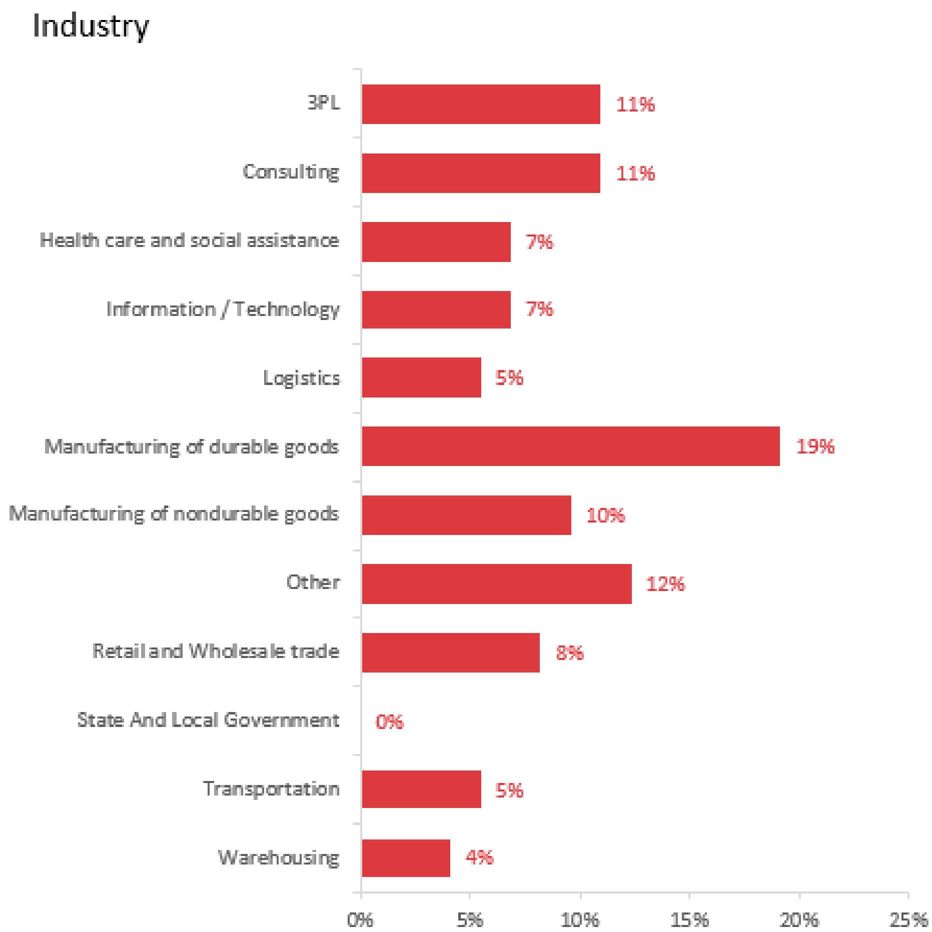
P1 = percentage of answers reporting an improvement

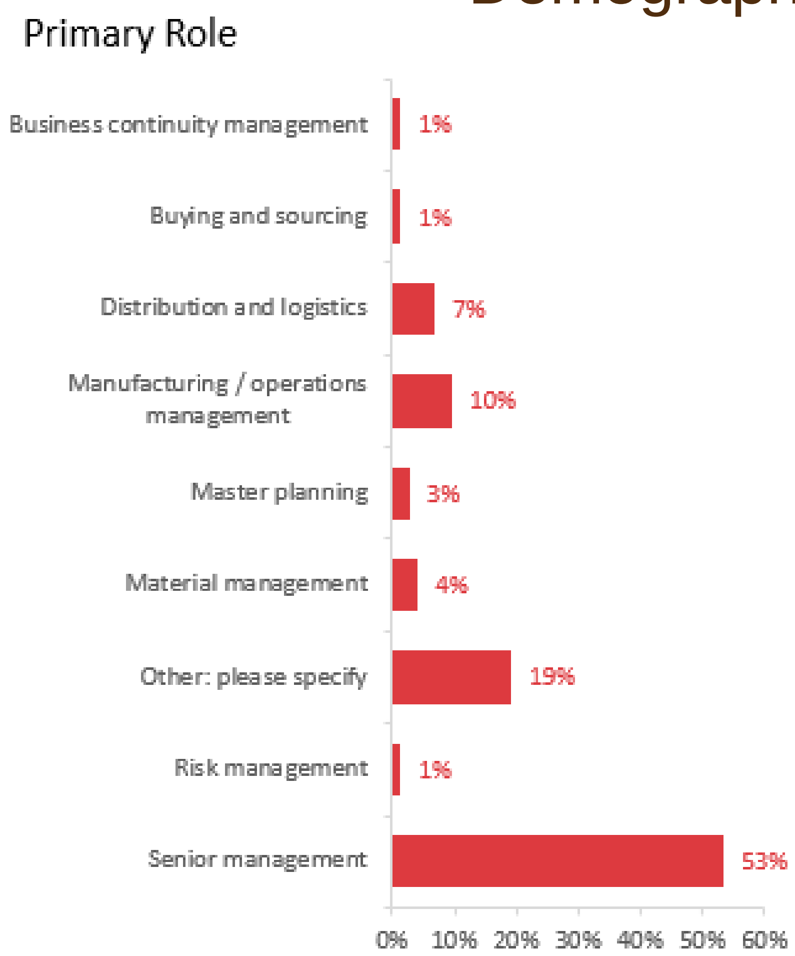
P2 = percentage of answers reporting no change

P3 = percentage of answers reporting a deterioration

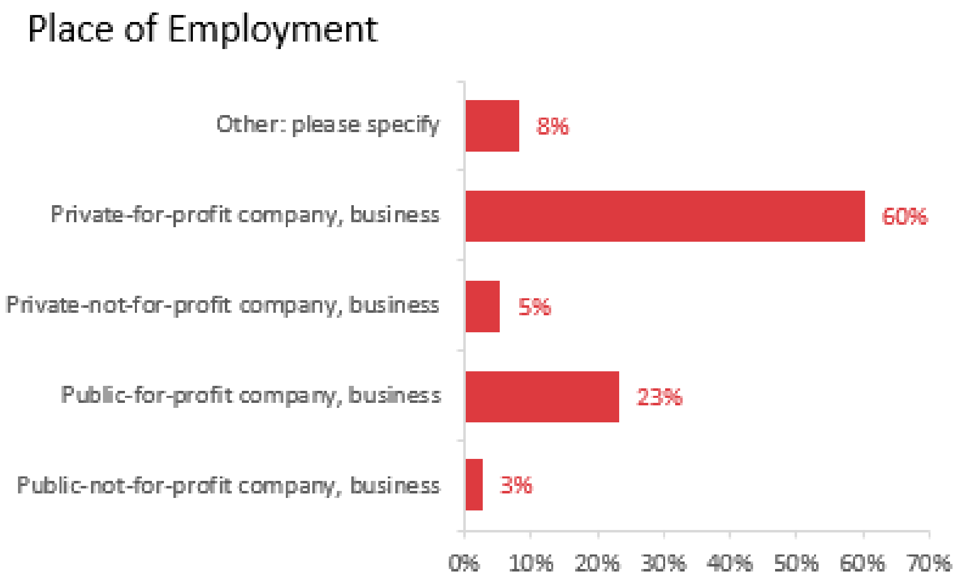
Appendix B
Survey Demographics







Primary Role
Business continuity management
Buying and sourcing
Distribution and logistics
Manufacturing / operations management
Master planning
Material management
Other: please specify
Risk management
Senior management
1%
1%
7%
10%
3%
4%
19%
1%
53%
0% 10% 20% 30% 40% 50% 60%



Place of Employment
Other: please specify
Private-for-profit company, business
Private-not-for-profit company, business
Public-for-profit company, business
Public-not-for-profit company, business
8%
60%
5%
23%
3%
0% 10% 20% 30% 40% 50% 60% 70%

Appendix B

Demographics (continued)