Measuring and Mitigating Supply Chain Risk

A TTI MarketEYE Executive Insights eBook




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Foreward

We have been living in unprecedented times. The world's electronic components supply chains have dealt with logistics issues, lack of available shipping capacity, labor shortages and increased demand for raw materials. All of this has happened as we've seen higher-than-ever demand for the very components used in manufacturing nearly everything electronic.

Ron Keith is an industry veteran and a trusted name in the supply chain world. We're proud to be able to present his approach to quantifying the risks to your company's supply chain so that you can come away from the challenges of 2020 and 2021 stronger, more aware of the risks you face and better prepared for the future.

One of the main ways to be prepared for that future is to have a trusted advisor who knows those challenges. We at TTI are ready to assist you not only with parts in stock, but with the Specialist knowledge that comes from decades of industry experience.

Measuring and Mitigating Supply Chain Risk

Ron Keith

There's been a lot of conversation of late about how to deal with supply chain risksin the wake of so many supply chain disruptions caused by COVID-19 and other issues. Tens of thousands of companies around the world suffered some loss of supply continuity as waves of the pandemic rippled through global supply chain links from Aachen to Zapopen.

2020 was the starkest reminder in years of the interconnectedness of global supply chains and how very fragile they can be. And although massive loss of supply continuity is a fresh wakeup call on the risks that all supply chains face, most supply chain risks are not so harshly binary.

Types of Supply Chain Risk

There are an almost immeasurable number of potential risks to supply chains, as grey-haired practitioners young and old can attest. But, at the most fundamental level, most supply chain risks can generally be categorized into three overarching risks when considered from the point of view of their impacts. These categories can be summarized as the risks to the following:

Economics of Supply:

This type of risk is not about the normal, de minimis fluctuations in the costs of raw material, components and labor. Risks to the economics of supply should focus on the possibility and probability of specific events, both systemic and idiosyncratic, that could have a "material adverse impact" on the cost of goods produced. Examples of risks to the economics of supply can include abrupt changes to the value of a foreign currency, loss of a primary mode of transportation or excessive reliance on a highly-constrained raw material, etc.

Quality of Supply:

Significant changes in the quality of supply can have a multiplicative impact on finished goods production, depending on the nature of the quality issue and where the problem arises in the value stream. Sudden changes in supply quality can be caused by disruptive labor actions, upstream changes to raw material or raw material sources, insufficient alternative supplier qualification, etc.

Continuity of Supply:

A significant decline in the availability of supply from the previous state. Consistent with the primary conversations in the industry today, I will focus on defining and measuring the primary risk to continuity of supply.

Of course, continuity and economics can never be fully decoupled, so for our purposes, we will define "continuity of supply" as the ability to continue to obtain the desired goods, with minimal disruption, at a reasonably consistent price.

Risk Factors Impacting Continuity of Supply

With all the talk today about building more resilient supply chains, it is important to recognize here that supply chain resilience is not the perfect antipode of supply chain risk, although they obviously exhibit a strong negative correlation to each other. The more resilient the supply chain design, the lower the risk – especially the risk to continuity of supply. There are innumerable sources of potential risk that can impact supply continuity, ranging from the mundane to the highly improbable. In general, the primary sources of supply chain risk can be group into one of these categories: Source Concentration, Lead Times, Obsolescence, Scalability, Geopolitical Risk, Natural Disasters, and Legal Risks.

Source Concentration

The extent to which raw materials, conversion activities, process equipment, etc. are single sourced, solesourced or sourced with a high level of geographic concentration.

Source concentration is not a major source of risk for widely-produced commercial off-the-shelf (COTS) parts, although it generally presents the greatest risk to custom and made-to-spec parts.

Lead Times

The lead time for raw material, conversion activities and even the process/test equipment used to produce the components, along with the variability of these lead times, is a major source of supply continuity risk.

This is obviously most problematic when component and raw material lead times exceed demand visibility for the finished product or the manufacturing planning horizon for that product. Instances where lead times for key material suddenly lengthen and move from within the planning horizon to well beyond the current planning horizon are a particularly acute source of risk.

Obsolescence

With device life cycles getting shorter, certain types of products are at increasing risk of disruptions to supply caused by component obsolescence, or decreased production volumes in anticipation of obsolescence.

The risk of obsolescence is often seen in far upstream raw materials as increasing environmental regulations make some material too costly or even illegal to produce.

Scalability

Understanding and quantifying what it takes to scale up output is critical to ensuring supply chain continuity. When the lead time required to scale up the volume of material or components is dramatically longer than your own demand visibility or planning horizon, scalability risk can be hard to foresee unless it is specifically being monitored and managed.

This type of risk is particularly problematic when your firm, or the aggregate demand of many firms, approaches a supplier's total capacity for a specific part.

Geopolitical Risk

Understanding the risks associated with government actions and regulations at key points in the supply chain is worth some attention in today's highly globalized supply chains. Geopolitical risks include bans on exports from producing countries and bans on imports for consuming countries.

Other risks in this category include targeted administrative slowdowns in export approvals, such as what we saw in July of 2019 when Japan took unilateral action to intentionally slow exports of the key semiconductor photoresist material fluorinated polyimide to Korea, sending shockwaves through the DRAM and Flash markets.

Natural Disasters

As global climate change contributes to more frequent cases of severe weather, the risks that natural disasters will impact parts of the supply chain are increasing at a nearly exponential rate.

Natural disasters not linked to climate change, such as earthquakes, tsunamis and volcanoes, can (and have, in recent memory) severely impacted tech supply chains.

Legal Risks

Although these disruptions are few and far between, they can have a devastating impact downstream in the supply chain. Raw materials and components designed or produced with proprietary technology that is currently under some legal dispute, or which have a pedigree that makes a legal dispute likely, are an almost totally overlooked source of risk.

Component shipments and even the production of components can be impacted by a legal settlement, or worse, temporarily halted as a means of providing injunctive relief for the aggrieved party. Additionally, courts around the world have occasionally ordered production halts, or even full plant closures, in response to everything from labor unrest to environmental infractions to unsafe working conditions.

Developing a Measure of Supply Chain Risk

The two key obstacles that prevent companies from developing more resilient supply chains are the inability to quantify specific risks and uncertainty around the potential impact of a specific risk event should it occur.

For the purpose of this exercise, let's label these as:

P_R =The probability of a specific risk event, and
I_R = The impact of a specific risk event

Also covered in the previous article was recovery time, which is defined as the total time an impacted supply chain takes to get back to its nominal, pre-event output. From the previous article we have the definition of recovery time as:

T_R = Recovery Time, which is the sum of T_L,
= Lost time and T_N = Repair time

The challenges associated with quantifying supply chain risks and their expected impact notwithstanding, it logically follows from the previous arguments that a good measure of supply chain risk could loosely be defined as:

Supply Chain Risk = (Probability of Risk) x (Impact of Risk) x (Recovery Time) or
$SC_R = (P_R) \times (I_R) \times (T_R)$

So, to develop a quantitative measure of supply chain risk, we need to determine or establish specific values for the three variables shown in the formula above. Determining appropriate values for these variables for each of the seven risk categories elaborated above, assigned across all of your key components and materials, and for each of your key vendors, provides a pretty powerful Supply Chain Risk Scorecard (SCRS).

Recovery time is best explained graphically, as shown in the figure below:

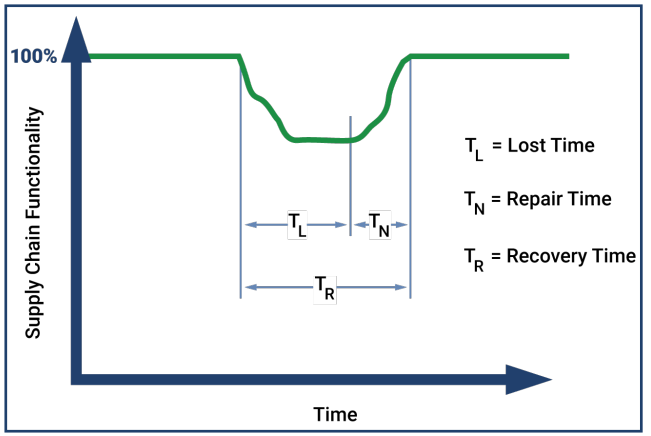

Figure 1: *Factors Associated with Recovery Time*

A Painstaking Process

Assigning values to these variables can involve elaborate, painstaking and costly research and analysis, or it can be made far less cumbersome by using a combination of thoughtful estimates and well-constructed proxies for each number assigned.

As so many of these probabilities and impacts are either probabilistic and/or not precisely knowable, thoughtful estimates may provide just as good of a result as more costly and intensive efforts of quantifying supply chain risks.

> *Thoughtful estimates may provide just as good of a result as more costly and intensive efforts of quantifying supply chain risks.*

Developing a Supply Chain Risk Scorecard

Let's walk through the basic steps of developing a quantifiable measure of supply chain risk that can help guide corporate actions and priorities – ultimately reducing overall supply chain risks.

To develop this quantitative measurement, we need to establish specific values for the three variables shown in the formula above. Determining appropriate values for three elements of your business allows you to construct a very useful Supply Chain Risk Scorecard. Those elements are:

1. **Your key components and materials …**
2. **… across each of your key vendors, and …**
3. **… for each of those previously-elaborated seven risk categories**

As daunting and time-consuming as this endeavor might seem, this is a case where the perfect cannot be allowed to be the enemy of the good. It is far better to go through this exercise with imperfect data than to not do it at all.

Assigning values to these variables need not involve elaborate, painstaking and costly research and analysis. It can be made far less cumbersome by using a combination of thoughtful estimates and well-constructed proxies for each number assigned.

As so many of these probabilities and impacts are either probabilistic, or not precisely knowable, thoughtful estimates may provide just as good of a result aselaborately quantifying the supply chain risks components of a Supply Chain Risk Scorecard (SCRS).

This process will in no way represent a perfectly quantified assessment of risk, but rather a means of determining relative risk across your supply chain so that risk reduction and risk mitigation measures can be prioritized to address the most significant risks.

To develop the Supply Chain Risk Scorecard inputs for your specific supply chain, products and demand profile, we must quantify both risk probability andrisk impact. We must also attempt to estimate recovery time.

I usually find recovery time to be the most problematic to estimate as it could be influenced by so many different factors. So, for estimating recovery time, I try to consider the most likely type of disruption for each risk category and figure out what the likely response would be.

In some extreme cases, recovery time may need to include selecting and qualifying a new part from a new vendor, which for some products (such as medical or aerospace designs) can be a fairly long process.

For each major source of supply chain risk, there are numerous ways to quantify probability and impact. For the purpose of this article, we will only talk about the methods of quantification superficially and focus more on developing the actual SCRS tool.

Developing Your Scorecard

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Estimating Your Level of Risk

With risk factors such as source concentration, lead time and scalability, your risk probability should be a proxy number derived in part from specific measures of each of these factors, rather than an actual probability.

A sole-sourced part generally has more risk than a part with multiple sources, and a part with a 26-week lead time is far more difficult to react to than a part with a two-week lead time. So, for simplicity, when substituting a proxy measure such as lead time for an actual calculated probability, it is best to use a specific set of proxy scores consistently across all of your various components and vendors,giving you an “apples to apples” comparison of risk.

The figures ahead provide an example of just one potential proxy set for source concentration risk and lead times, but there are numerous other approaches that could also be used effectively.

How long would take for a supplier to add some level of additional capacity?

Figure 2: *Example of Possible Proxy Scale for Source Concentration*

Component Source Description	Source Concentration Risk P_R Proxy
Sole Sourced at Single Facility	10
Single Sourced at Single Factory	8
Single Sourced / Multiple Factories	6
Dual Sourced / Multiple Factories	2
Grows on Every Tree in the World	0

Figure 3: *Example of Possible Proxy Scale for Lead Time*

Component Lead Time Description	Lead Time Risk P_R Proxy
Greater Than 12 Weeks	10
8 to 10 Weeks	8
4 to 6 Weeks	6
Less Than 4 Weeks	2
I Have a Supply Chain Time Machine	0

Similar proxy measures should be developed for other risk factors, such as scalability, which can be best quantified as some specific measure that is not an actual probability.

Most often, the risk to loss of supply continuity associated with scalability relates to a supplier's ability or inability to expand output to meet demand – especially un-forecasted demand.Developing a proxy measure for scalability risk most often involves determining the amount of time it would take for a supplier to add some defined level of additional capacity.

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Figure 4: *Example of Possible Scale for Impact of Risk*

Impact of Risk Description	Imapct of Risk I_R Proxy
Impacts > 20% of Revenue	10
Impacts < 20% > 15% of Revenue	8
Impacts < 15% > 5% of Revenue	6
Impacts < 5% > 1% of Revenue	2
We Don't Even Use This Part	0

Figure 5: *Example of Possible Scale for Recovery Time*

Est. Recovery Time Description	Recovery Time T_R Proxy
Greater Than 12 Weeks	10
8 to 10 Weeks	8
4 to 6 Weeks	6
Less Than 4 Weeks	2
We Had Too Much Inventory Anyway	0

In a more detailed model, a risk impact number would be derived based on a broader range of considerations, including the economics, brand protection and longer-term customer impact of the loss of supply on a particular product. Spending a bit of extra time to really understand the impact of a loss of supply continuity can be a very useful exercise, and almost always reveals important issues beyond the obvious immediate financial impact.

Other risk factors from the list above should also be estimated on a consistent scale.For issues like geopolitical risk and natural disaster risk, there are a number of governmental on non-profit organizations that publish data that could be useful in constructing your risk scale.The OECD, World Bank, United Nations, NOAA and others can be good sources for helping to build your risk scale and determining how risky various supplier locations may be.

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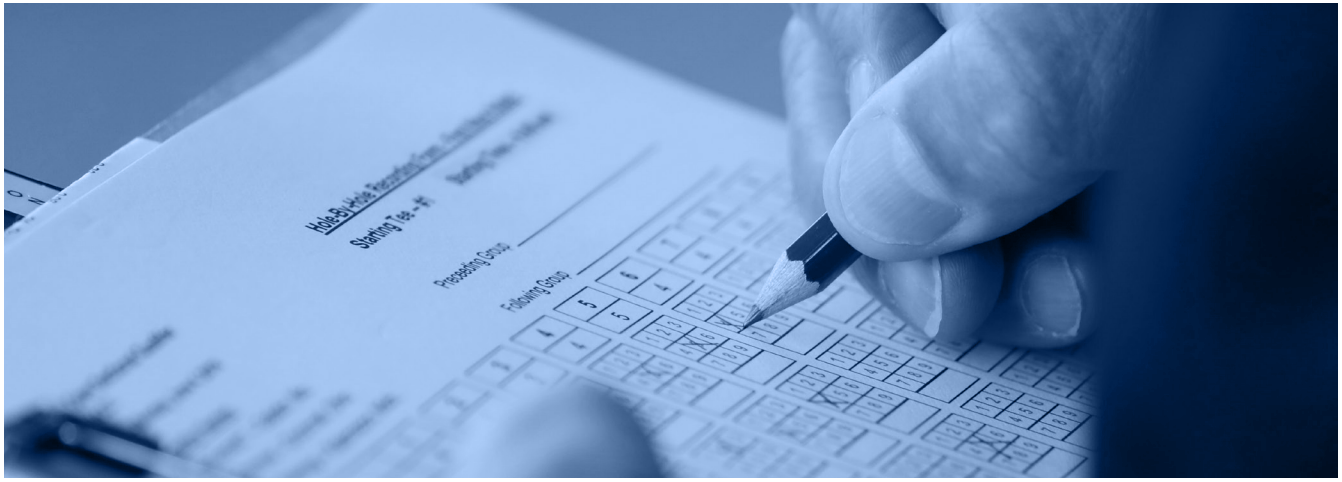
Building Your Scorecard

Now that we've been through the basics of developing the various inputs, it's time to assemble them into an overall scorecard to get a broader picture of where your biggest supply chain risks lie.

When compiling the SCRS, every component or subassembly in the product should be subject to this scoring process, except for widely-available COTS components produced by numerous vendors according to some widely agreed-upon industry standard.

The scorecard should be arranged by supplier, with all of the parts from each supplier listed and scored together.



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The scorecard should be arranged by supplier, with all of the parts from each supplier listed and scored together.

On the left side of the scorecard are the total risk scores for each component.This risk score is the sum of all of the individual risk scores whichare derived by multiplying the risk probability number by the risk impact number and then multiplying that by the recovery time number for each risk category.

So, to get the total risk score for each component, simply take the sum of all of the individual risk scores, or:

$$SCRS = \Sigma\ (P_R) \times (I_R) \times (T_R)$$

To calculate the individual risk factor score at the supplier level, just take the average of all of the individual scores (Probability, Impact and Recovery Time) for each of your seven risk factors and multiply them together.

For the overall risk score at the supplier level, we do just as we did at the component level and take the sum of all of the individual factor risk scores. This is best illustrated below in a summary presentation of the risk scorecard that does not show all three components.

Looking at the example scorecard above, we can see that one particular supplier has a very high overall risk score.There are also a number of individual components that show an elevated level of risk.

Rank-ordering the risks scores from highest to lowest is a good way to get an initial feel for where to focus your attention on supply chain risk mitigation for the future.

Figure 6: *Sample Supply Chain Risk Scorecard – Detailed*

SCRS	Supplier & Component PN.	Description	Source Con. P_R	Source Con. I_R	Source Con. T_R	Lead Time P_R	Lead Time I_R	Lead Time T_R	Obsolescence P_R	Obsolescence I_R	Obsolescence T_R	Scalability P_R	Scalability I_R	Scalability T_R	Geo-Political P_R	Geo-Political I_R	Geo-Political T_R	Natural Disaster P_R	Natural Disaster I_R	Natural Disaster T_R	Legal & IP P_R	Legal & IP I_R	Legal & IP T_R
781	**Acme Anvil Company**		**5.7**	**5.3**	**5.3**	**7.3**	**5.3**	**5.3**	**1.3**	**5.3**	**9.0**	**4.7**	**5.3**	**8.0**	**1.0**	**5.3**	**7.3**	**1.0**	**5.3**	**7.3**	**1.0**	**5.3**	**5.3**
1274	047-123-4958	RoadRunner65X	9	7	6	8	7	6	2	7	9	5	7	8	1	7	8	1	7	8	1	7	6
590	047-123-4602	CactusKillerZ650	4	5	5	6	5	5	1	5	9	5	5	8	1	5	7	1	5	7	1	5	5
480	047-123-4988	WileyCoyote247P	4	4	5	8	4	5	1	4	9	4	4	8	1	4	7	1	4	7	1	4	5
1275	**Desert Dynamite Ltd.**		**8.0**	**6.0**	**4.3**	**6.3**	**6.0**	**4.0**	**3.0**	**6.8**	**9.0**	**4.5**	**7.3**	**9.0**	**4.0**	**6.8**	**8.0**	**3.0**	**7.0**	**8.0**	**1.5**	**7.5**	**4.0**
1742	044-984-1776	XL Boom 15XC	8	6	5	8	6	4	5	7	9	7	9	9	4	7	8	3	7	8	1	9	4
942	046-120-1988	BigBoom 1400	8	6	4	5	6	4	1	6	9	4	6	9	4	6	8	3	6	8	1	6	4
1190	044-984-1776	XX Box 18Q50	8	6	4	6	6	4	3	7	9	3	7	9	4	7	8	3	7	8	3	7	4
1225	044-964-1776	Powder Barrell	8	6	4	6	6	4	3	7	9	4	7	9	4	7	8	3	8	8	1	8	4
209	**Phoenix Pianos LLC**		**2.0**	**3.0**	**5.0**	**3.3**	**3.0**	**5.0**	**1.0**	**3.0**	**8.3**	**2.7**	**3.0**	**6.0**	**1.0**	**2.7**	**6.3**	**1.0**	**3.0**	**6.3**	**1.0**	**3.0**	**5.0**
144	044-654-1789	Piano Lever 600	2	3	5	3	3	5	1	3	7	2	3	3	1	2	3	1	3	3	1	3	5
324	037-111-1492	150 Ft Fall 12X	2	4	5	4	4	5	1	4	9	3	4	7	1	4	8	1	4	8	1	4	5
158	047-128-8188	Big Smash 850XL	2	2	5	3	2	5	1	2	9	3	2	8	1	2	8	1	2	8	1	2	5

Figure 7: *Sample Supply Chain Risk Scorecard – Simplified*

SCRS	Supplier & Component PN.	Description	Source Concentration	Lead Time	Obsolescence	Scalability	Geo-Political	Natural Disaster	Legal & IP
781	**Acme Anvil Company**		**161.2**	**208.6**	**64.0**	**199.1**	**39.1**	**39.1**	**28.4**
1274	047-123-4958	RoadRunner65X	378	336	126	280	56	56	42
590	047-123-4602	CactusKillerZ650	100	150	45	200	35	35	25
480	047-123-4988	WileyCoyote247P	80	160	36	128	28	28	20
1275	**Desert Dynamite Ltd.**		**204.0**	**150.0**	**182.3**	**293.6**	**216.0**	**168.0**	**45.0**
1742	044-984-1776	XL Boom 15XC	240	192	315	567	224	168	36
942	046-120-1988	BigBoom 1400	192	120	54	216	192	144	24
1190	044-984-1776	XX Box 18Q50	192	144	189	189	224	168	84
1225	044-964-1776	Powder Barrell	192	144	189	252	224	192	32
209	**Phoenix Pianos LLC**		**30.0**	**50.0**	**25.0**	**48.0**	**16.9**	**19.0**	**15.0**
144	044-654-1789	Piano Lever 600	30	45	21	18	6	9	15
324	037-111-1492	150 Ft Fall 12X	40	80	36	84	32	32	20
158	047-128-8188	Big Smash 850XL	20	30	18	48	16	16	10

Ron Keith is a career operations professional who has served in engineering, manufacturing and executive management positions atWestinghouse, Rockwell, Alcatel and Flextronics International. He is thefounder and executive director of Supply Chain Resources Group Inc., a globalmanaged services and consulting company with operations in the US, Mexico,China, Thailand, Vietnam and Taiwan.

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TTI, Inc., a Berkshire Hathaway company, is an authorized, specialty distributor of electronic components. Founded in 1971, the emphasis on a broad and deep product portfolio, available-to-sell inventory and sophisticated supply chain programs has established TTI as a distributor of choice to manufacturers in the industrial, defense, aerospace, transportation, medical and communications sectors worldwide.

TTI and its wholly owned subsidiaries, the TTI Family of Specialists – Mouser Electronics, Sager Electronics and TTI Semiconductor Group – employ over 7,300 people in more than 136 locations throughout North America, South America, Europe, Asia and Africa. Globally, the company maintains over 3 million square feet of dedicated warehouse space in 30 distribution centers, housing over 850,000 component part numbers.

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