HYPERION RESEARCH

Special Analysis

Challenges and Opportunities for Securing a Robust US Quantum Computing Supply Chain

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EXECUTIVE SUMMARY

Based on a survey of quantum computing (QC) commercial entities spanning the QC ecosystem, there are significant concerns that there could be a serious QC-related supply chain disruption in the next few years. Potential choke points are widely dispersed across the supply chain spanning assured access to necessary raw materials to a steady supply of trained software experts. Further complicating this issue is that the QC sector is currently in a nascent and rapidly changing state with a spate of new technologies, hardware and software implementations, and related production and distribution schemes yet to be firmly established. The QC sector will likely remain fluid for at least the next few years, and the establishment of a well-defined, complete, and stable supply chain for the sector will remain in flux for at least as long, if not longer.

In order to generate a first-order understanding of key QC supply chain issues and to better assess the current and potential future choke points for the domestic QC supply chain, Hyperion Research, at the behest of QED-C®, recently conducted a survey seeking information and insights on the various challenges facing the global QC supply chain. The survey was sent to a wide and diverse collection of primarily US-based QC organizations, and input was collected from 47 different respondents with participation across a broad base of the US QC supplier base.

Key findings of this survey included:

Nearly 60% of survey respondents indicated that some form of a QC supply chain disruption was likely in the next three years relating to materials, components, or sub-assemblies supplied to the QC sector or QC-related goods and/or services marketed to end users. Specifically, 32% of respondents indicated that such an event was very likely, while 26% indicated it was somewhat likely.

When asked what would be the single most likely cause of a QC-related supply chain disruption within their organization in the next three years, respondents answered that access to key raw materials and manufacturing/assembly equipment would be the most likely candidates. The two next most selected options were related to access to needed technical expertise in either hardware of software design/production. Only 6% of respondents saw access to R&D funding as a major QC choke point in the next three years.

- Strong concerns with assured access to raw materials and manufacturing/assembly equipment may represent apprehensions by QC suppliers to end user markets that they only have indirect access to – and hence little control over – the lowest and most basic levels of the overall QC supply chain.

- In contrast, respondents across the QC supplier sector exhibited little to no concern over access to QC markets, either domestic or foreign, as a supply chain issue within the three years.
- When asked how long it would take their organization to find an alternate supplier for their single most critical manufacturing choke point, the most selected response was more than one year, followed by between nine months and one year.

Survey respondents had strong opinions on the value of various US government policy initiatives related to QC supply chain dynamics. In general, the policy initiatives deemed most beneficial centered on increased support, both financial and technical, from US government programs, while any initiatives that could hinder US QC supplier efforts to freely engage in a global QC ecosystem were deemed detrimental. Specifically:

- Survey respondents considered the most beneficial US government policy initiatives to be increased direct government funding for organization's quantum R&D, improved and expanded US Government-conducted quantum R&D programs, and increased and strengthened R&D incentives, such as R&D tax credits, for their organization's quantum R&D expenses.
- US policy options that were considered very detrimental included more severe import/export tariffs, strengthened deemed export policies, and more stringent goods and services export control regulations.

Owing to the broad range of US QC supply chain concerns, US policy options to eliminate, or even lessen, the specter of any significant QC supply chain disruptions are neither clear nor reducible to a one size fits all solution. Ultimately a comprehensive range of mutually reinforcing initiatives will be needed to adequately secure all aspects of the US QC ecosystem. At the same time, these programs, as is typical for any critical advanced technology, must address key US government use cases for the technology while furthering the overall and global competitive ability of the domestic commercial sector. Suggested next steps include:

- Continual tracking of the overall dynamics of the US QC supply chain to identify the most critical vulnerabilities from either domestic or foreign sources, especially as the current QC supply chain is continually shifting with new vulnerabilities rising and falling as the technology evolves.
- Continued US government support to the sector in the form of research partnerships or direct funding for at least the next few years as a way to encourage QC-related funding within the commercial QC sector while demonstrating to the large pool of potential QC end users that QC technology will soon evolve into a stable, mature, and economically beneficial market sector.
- Careful monitoring of foreign QC commercial and government efforts to foster their own domestic and independent QC ecosystem, particularly in those countries with national security agenda concerns. Such foreign efforts become even more critical in cases where foreign policies, either deliberately or as an unintended side effect, have a detrimental effect on the US QC commercial sector's ability to compete fairly in that country or region.

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OVERVIEW

The quantum computing (QC) sector is currently in a nascent state and will likely remain so for at least the next few years. The establishment of a well-defined, complete, and stable supply chain for the sector will remain in flux for at least as long, if not longer. Many of the traditional supply chain issues typical to more established sectors such as sourcing of raw materials, related manufacturing equipment availability, and even workforce composition has yet to be fully determined for the QC sector.

For example, the range of various quantum modalities - the physical implementations used to establish the needed quantum effects to support quantum processing - is broad and still open to an evolving set of material and related equipment requirements. Likewise, various QC-related subcomponent technologies, such as microwave devices, cryogenic coolers, photon and laser sources and detectors have yet to be fully defined. Similar unknowns proliferate across the QC hardware and software ecosystem. Finally, some of the larger political, economic, and societal issues surrounding the QC sector have only begun to be explored and their impacts remain uncertain.

In order to generate a first-order understanding of key QC supply chain issues and to better assess the current and potential future choke points for the domestic QC supply chain, Hyperion Research, at the behest of QED-C, recently conducted a survey seeking information and insights on the various challenges facing the US-based QC supply chain. The key issues this survey sought to expose included:

- A supply chain adequate to support the US QC hardware sector that spanned the supply of raw materials, subcomponents, and related sub-assemblies, the ability to develop and market end-user facing QC hardware systems, the challenges of access to a qualified workforce for both R&D and manufacturing requirements, and issues surrounding the channels to transport or distribute QC components or finished systems.
- The complementary supply chain necessary to support the development of quantum computing algorithms, middleware, applications, and other related software and services. Concerns here centered on the issue of workforce development and availability of critical R&D and operations personnel as well as access to both foreign and domestic skills.
- The key perceived benefits and limitations of both domestic and foreign government QC-related policies, programs, and practices which included R&D funding, tax incentives, directed procurements, export controls, and national security agenda overlays.

The survey, which consisted of 27 questions, was conducted between March 7 and March 30, 2022, and was sent primarily to a wide and diverse base of US-based QC organizations, chiefly current members of the US Government-funded Quantum Economic Development Consortium (QED-C). Ultimately, input was collected from 47 different respondents with participation across a broad base of the US QC supplier base.

KEY DEMOGRAPHICS OF QC SUPPLY CHAIN SURVEY

Establishing credible and insightful results from any survey rests heavily on the quality of those who respond to the survey. As such, the following requirements for survey participation in this particular effort as well as the related demographics of those included in the survey results are summarized below.

When asked about how knowledgeable they were about their organization's overall supply chain needs to either supply or directly produce QC related goods or services, 70% of survey respondents indicated that they were very knowledgeable, and 30% said they were fairly knowledgeable. Any respondent indicating less knowledge about the topic was screened out of the survey.

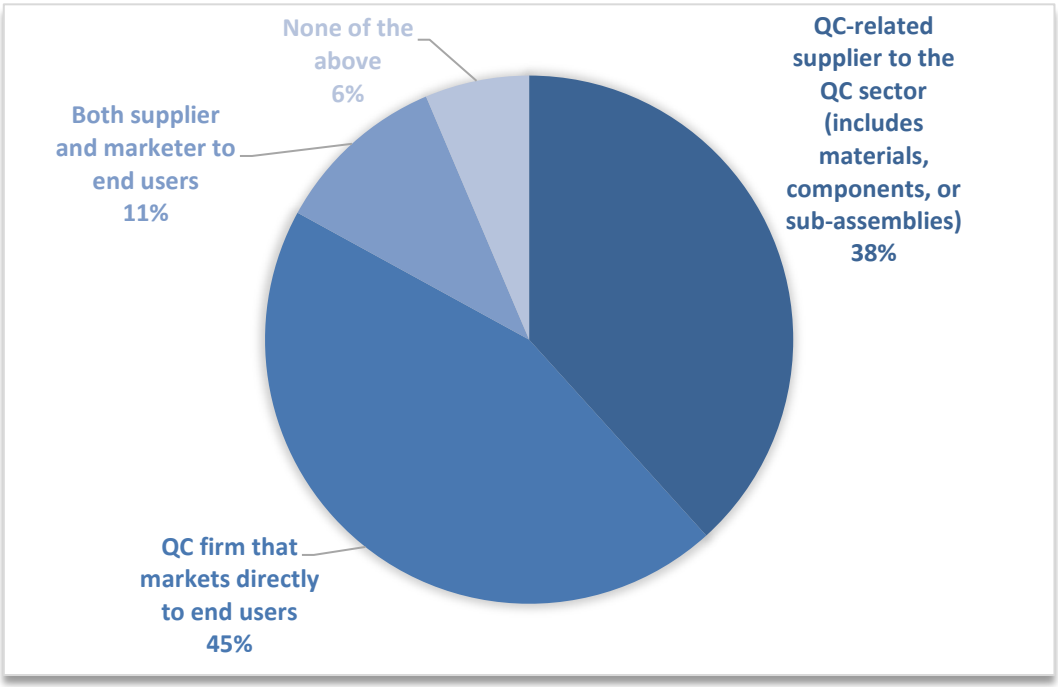
In response to a question regarding the location of their company headquarters, the majority (79%) of respondents indicated the United States. However, although QED-C is primary a US-based entity, it does increasingly support the inclusion of non-US entities, and as such non-US based organizations were contacted to participate in this effort.

- For this survey, 6% of respondents indicated their organizations' headquarters were in the UK, 4% in Canada, and 2% in Australia, Ireland and Japan. The remaining 5% listed no specific country.

As seen below in Figure 1, when asked what type of QC organization they represented, 45% of survey respondents selected QC commercial entities that marketed either QC-related hardware, software, or some combination of both, directly to end users. More than one third (38%) of respondents represented QC-related suppliers to the QC sector including those who supply either materials, components, or sub-assemblies used in the process of assembling finished QC hardware or software for commercial sale. 11% of respondents indicated that they have a role as both a supplier of components as well as finished products.

FIGURE 1

QC Organization Description



Note: Sample Size = 47

Source: Hyperion Research, 2022

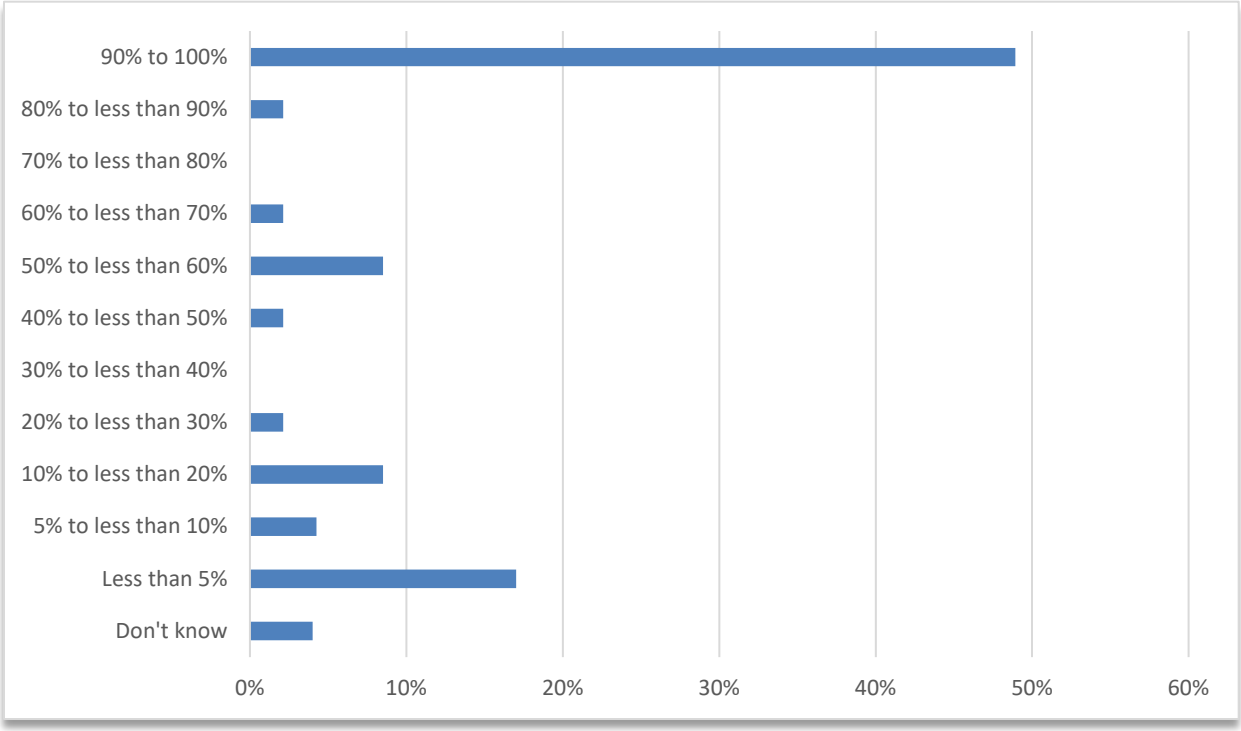
Although the survey did not collect which end user markets were targeted by these companies, companion Hyperion Research studies reveal significant interest in QC capabilities across a wide range of commercial verticals that include advanced manufacturing, aerospace, automotive, bio-science, chemicals, computer products, defense, finance, healthcare, manufacturing, oil & gas, pharmaceuticals, and telecommunication.

When asked about revenues derived from QC sales as a percentage of their organization's overall revenues, as seen below in Figure 2, almost half (49%) of the respondents indicated that almost all (90% to 100%) of their revenues were related directly to QC-related activities. The second most selected answer was less than 5% of revenues, chosen by almost one in five (17%). The remainder were scattered across the various options.

- These results indicate that for a majority of the QC commercial firms surveyed, their quantum computing efforts represent most if not all of their commercial interests and that their continued survival in the sector is likely contingent on a strong and stable QC supply chain.
- Conversely, the near one in five companies that derive less than five percent of their total revenues from QC-related revenues have much less to lose in the event of a significant QC supply chain issue and could easily exit from the sector without incurring any significant decline in their overall revenue stream.

FIGURE 2

Organization's QC Revenues as Percentage of Total Revenues



Sample Size = 47

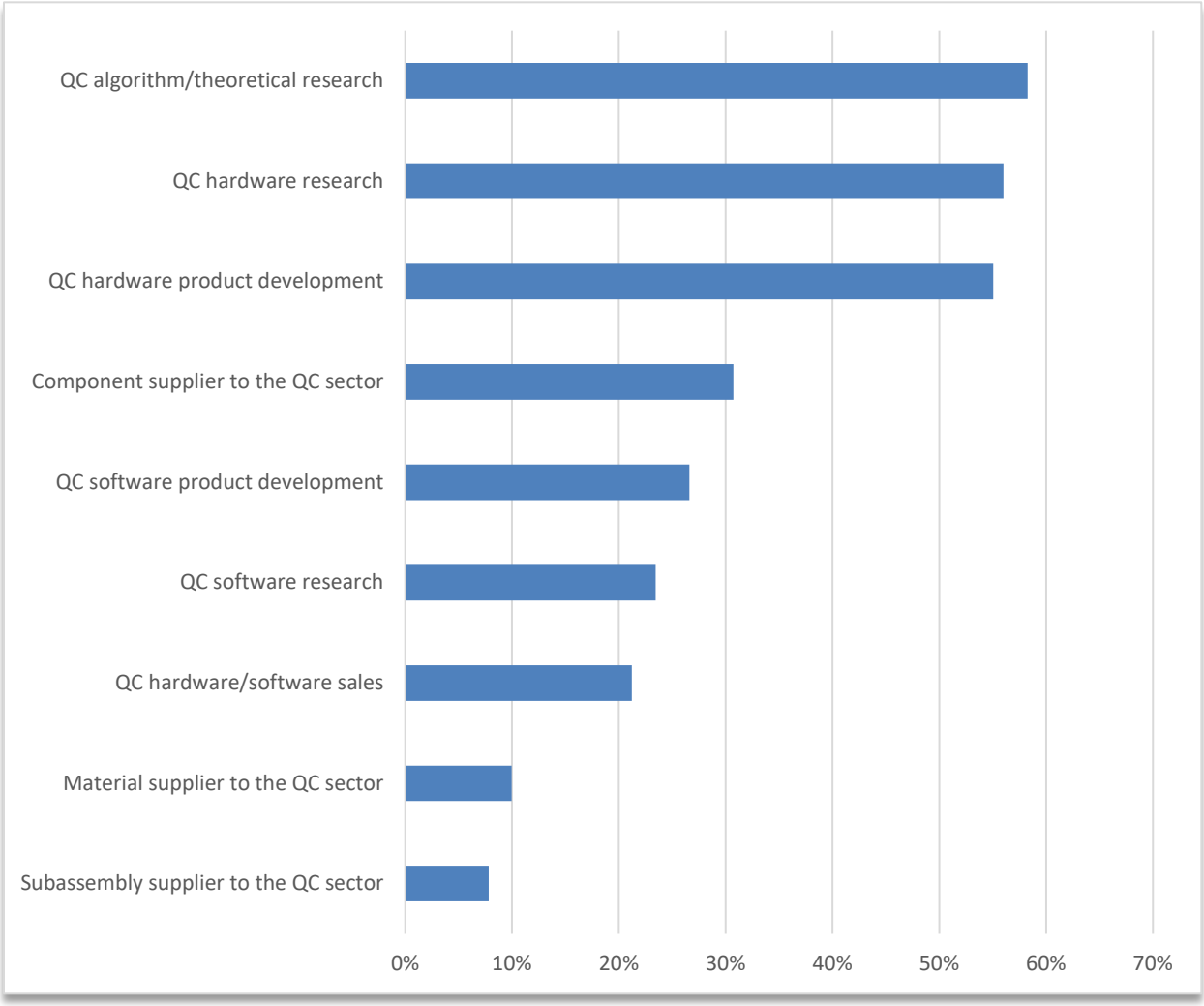
Source: Hyperion Research, 2022

As seen in Figure 3 below, when asked about the specific development area(s) that their organization was currently involved in, given the choice to select as many options as appropriate, the combination of the top three most selected options were QC algorithm/theoretical research (58%) and hardware related efforts either through QC hardware research (56%) or hardware development (55%).

- The findings likely represent a good representation of the overall composition of the US QC sector currently, consisting of the three main sectors: QC algorithm/software, QC hardware and QC component, material, or subassembly suppliers.

FIGURE 3

Combined Top Three QC Development Area of Surveyed Organizations



Sample Size =47, Respondents combined top three choices.

Source: Hyperion Research, 2022

Table 1, below, contains a more detailed listing of the respondents' top three QC development areas with their organizations.

Table 1

Specific QC-Related Development Area(s)

	First choice	Second choice	Third choice
QC algorithm/theoretical research	55%	0%	3%
Component supplier to the QC sector	23%	7%	0%
QC hardware product development	11%	41%	3%
QC hardware research	2%	10%	44%
QC hardware/software sales	2%	7%	12%
Material supplier to the QC sector	2%	5%	3%
QC software product development	2%	10%	15%
QC software research	0%	15%	9%
Subassembly supplier to the QC sector	0%	5%	3%

Note: Sample Size= 47, Respondents could select all options that applied. Their choices do not necessarily reflect any particular ordinal preference.

Source: Hyperion Research, 2022

OVERALL SUPPLY CHAIN PERCEPTIONS

The following sections detail some of the survey's key findings that relate to overall QC supply chain concerns as well as a more concentrated look at supply chain issues for materials, components, and QC finished products as well as QC-related software and services. The time frame of these questions was limited to the next three years.

- This reflects not only the imperative to collect information on near-term QC supply chain issues but also to highlight the nature of its uncertain and continually evolving state.

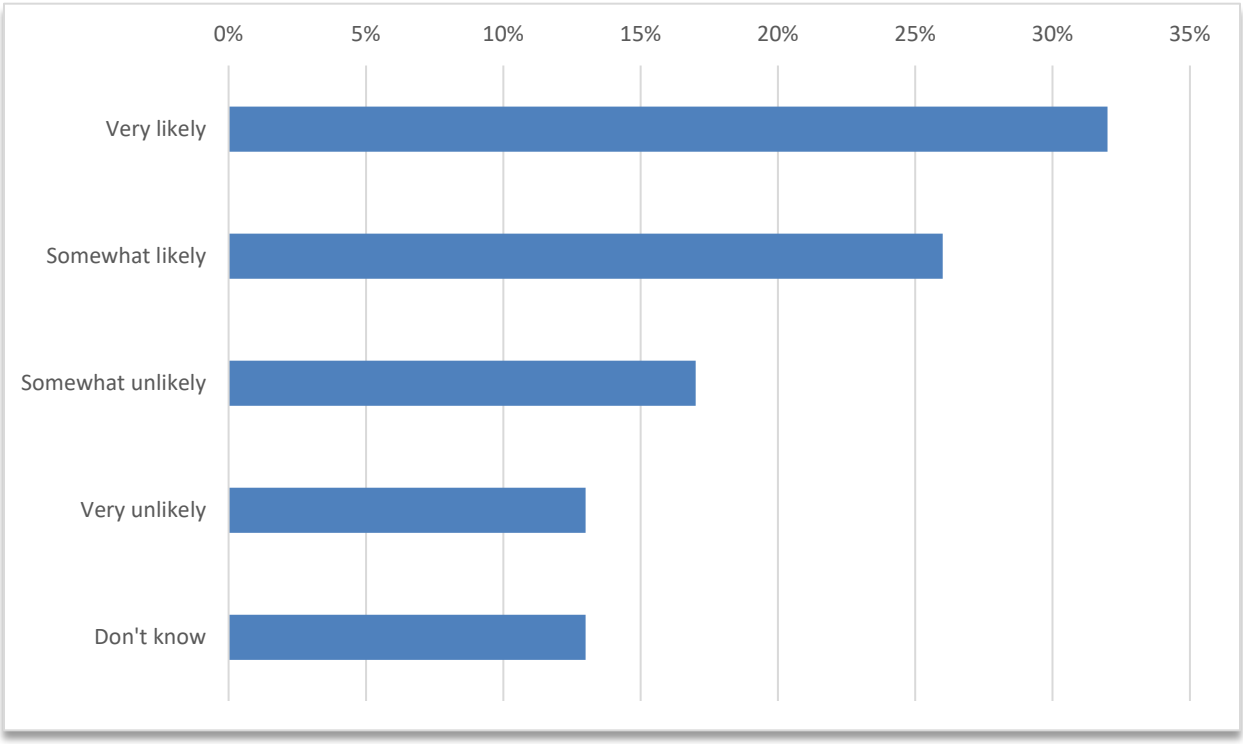
As seen below in Figure 4, when asked how likely it is that their organization would experience at least some QC-related supply chain disruption that would affect their ability to either supply materials,

components, or sub-assemblies to the QC sector or directly market QC-related goods and/or services to end users, 58% said such an event was likely: 32% very likely and 26% somewhat likely. About one third (30%) said such an event was unlikely: 17% somewhat unlikely and 13% very unlikely.

- Respondents who foresaw some form of a QC supply chain issue outnumbered those who did not by a factor of about two to one.
- Regardless of these respondents' ability to accurately assess the potential for any real supply chain disruption, the results indicate that a broad collection of QC suppliers are expecting, and perhaps are already laying the groundwork to mitigate the impact of, such an event.

FIGURE 4

Likelihood of QC Supply Chain Issue in Next Three Years



Sample Size = 47

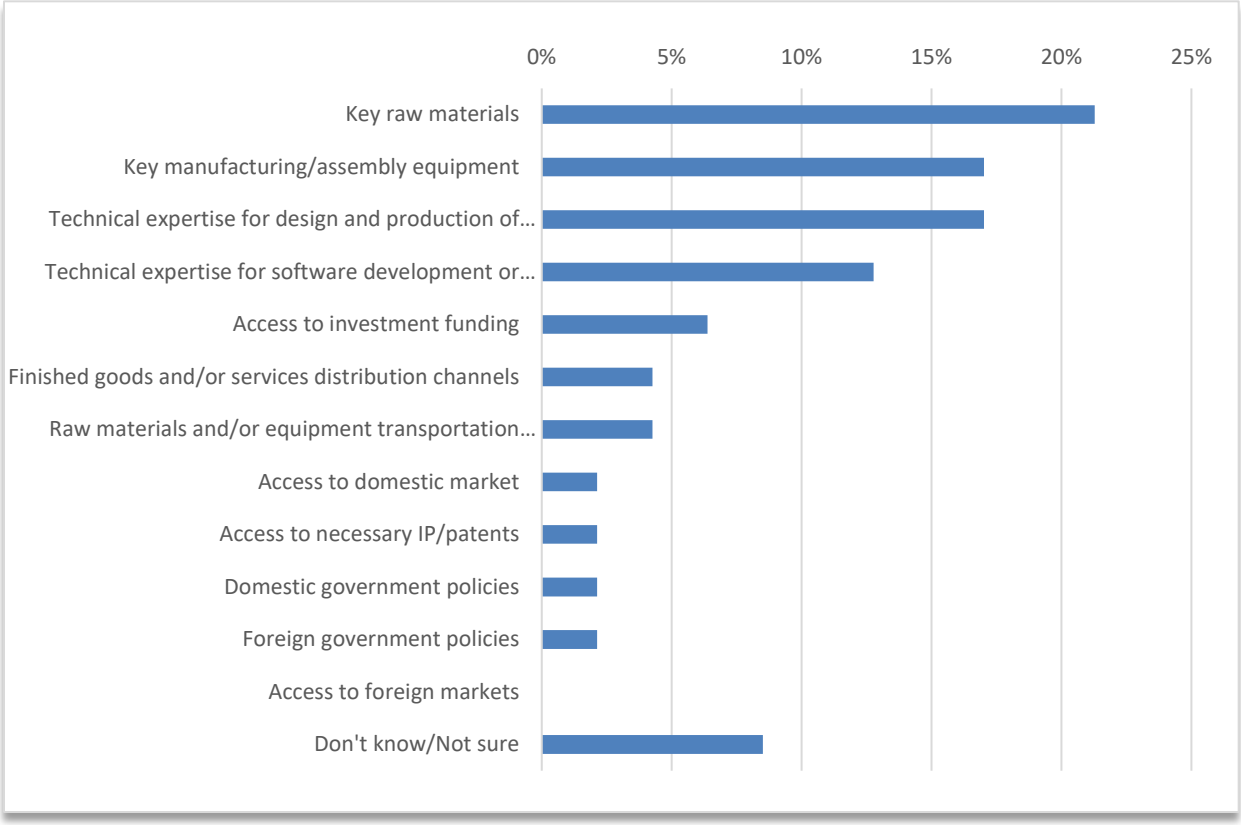
Source: Hyperion Research, 2022

When asked what would be the single most likely cause of a QC-related supply chain disruption within their organization in the next three years, respondents answered, as seen below in Figure 5, that access to key raw materials (21%) and manufacturing/assembly equipment (17%) would be the most likely candidates. The two next most selected options were both related to access to needed technical expertise in either hardware (17%) or software (13%) design/production.

- Strong concerns about raw materials and manufacturing/assembly equipment may represent apprehensions by QC suppliers to end user markets that they only have indirect access to – and hence little control over – the lowest and most basic levels of the overall QC supply chain.
- In contrast, respondents across the QC supplier sector exhibited little to no concern over access to markets, either domestic or foreign, as a supply chain issue within the next three years.

FIGURE 5

Most Likely Cause of a QC Supply Chain Interruption in the Next Three Years



Sample Size = 47

Source: Hyperion Research, 2022

QC SUPPLY CHAIN ISSUES FOR MATERIALS, COMPONENTS, AND FINISHED QC PRODUCTS

The following section focuses on QC suppliers' concerns related specifically to materials, components, subassemblies, or finished QC manufactured products. As such, the base of respondents was restricted to those involved in that part of the QC sector who had relevant concerns with QC supply chain issues. Specifically, of the total 47 survey participants, 35 indicated that they were directly involved in one or more of these sectors.

- Of those 35, 24 (68%) foresaw some form of a QC supply chain issue.
- As a result, unless indicated otherwise, the sample size for this section is 24.

Table 2 below list the top three most critical manufacturing choke points that respondents' organizations either now have or will likely have over the next three years in their QC-related supply chain. Taken together, the respondents' wide range of identified potential QC choke points in their supply chain suggests that no single solution will be able to adequately address all of these choke points but instead will require a broad set of corrective measures.

Table 2

Critical Choke Points for QC Materials, Components, and QC Finished Products in Next Three Years

	First choice	Second choice	Third choice	Total
Reliable access to key hardware subcomponents	42%	16%	19%	76%
Reliable access to key skilled workforce	4%	26%	6%	37%
Reliable access to skilled scientific/engineering/technical workforce	13%	11%	13%	36%
Reliable access to key manufacturing equipment	13%	16%	6%	35%
Reliable access to key processed materials	8%	5%	19%	32%
Reliable access to key raw materials	13%	0%	19%	31%
Reliable access to a material and/or goods distribution channel	4%	11%	13%	27%
Reliable access to a material and/or goods distribution channel alternative	4%	5%	6%	16%
Reliable access to necessary compute/design/test equipment and related software	0%	5%	0%	5%
Reliable access to critical IP and patents	0%	5%	0%	5%
Don't know/Not sure	0%	0%	0%	0%

Note: Sample Size = 24, Respondents could select up to three options. Their choices do not necessarily reflect any particular ordinal preference.

Source: Hyperion Research, 2022

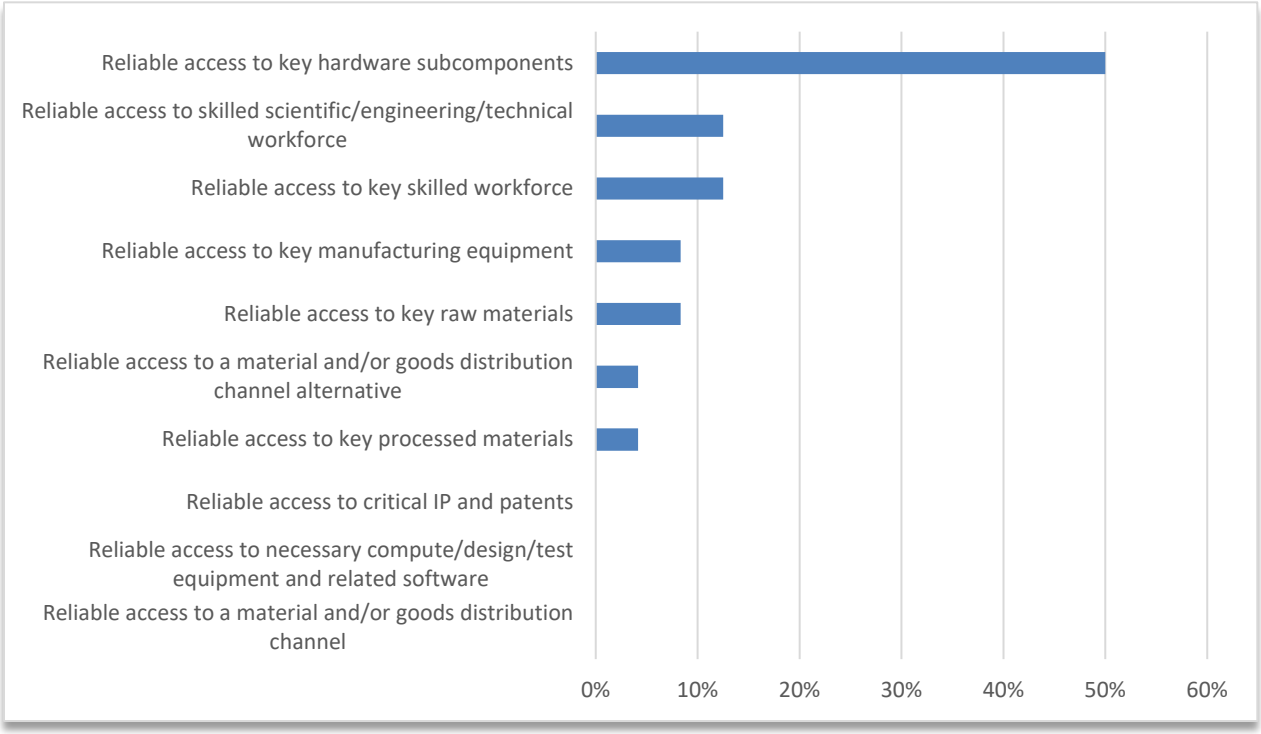
Respondents were also asked to provide additional detailed information on potential materials, components, subassemblies, or finished QC manufactured products choke points. They are summarized below:

- Materials including, He-3 gas, silicon-28, copper, aluminum, and gold.
- Components and Subassemblies including high performance cryocoolers, pumps, valves, compressors, power supplies, RF generators, superconducting wiring assemblies, dilution fridge components, fiber and coaxial cables, low noise lasers at relevant atomic wavelengths, and key manufacturing equipment useful for quantum and classical chip manufacturing and testing.
- Skilled workforce including optical, mechanical, electronics engineers, and software developers.

When asked about the single most critical manufacturing choke points that their organization either now has or will likely have over the next three years in their QC-related supply chain, as seen below in Figure 6, the most selected answer by a wide margin was access to key hardware subcomponents, selected by 50% of all respondents, more than three times the rate of the second and third most selected responses – access to skilled technical or skilled general workforce (13% each).

FIGURE 6

Single Most Critical QC Choke Point for Materials, Components, and QC Finished Products in Next Three Years



Sample Size = 24

Source: Hyperion Research, 2022

When asked about the country in which the single most critical manufacturing choke point identified in Figure 6 would most likely be centered, as seen in Table 3 below, the most often selected response, by a wide margin, was the United States (68%). A handful of other counties including China, Germany, Japan, and the United Kingdom were also cited, but at a much lower rate.

- The sample size is too small to support any significant conclusions from this finding, but it does indicate that the US QC supply chain ecosystem is seen, to a great extent, as contained within the United States.
- However, additional examination of foreign dependencies is likely warranted in order to better assess key potential foreign choke points.

Table 3

Potential Choke Points' Country of Origin

	% Respondents
China	8
Germany	8
Japan	4
United Kingdom	4
United States	68
Other	8

Note: Sample Size = 24

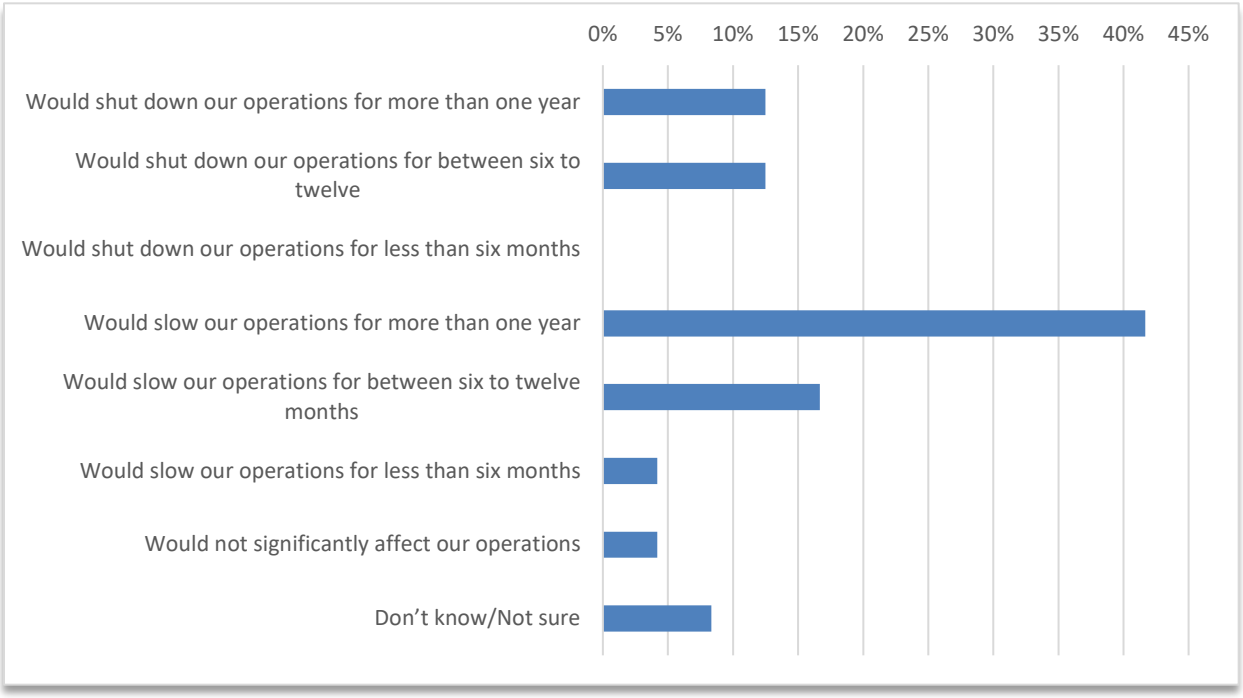
Source: Hyperion Research, 2022

As seen below in Figure 7, when asked what the impact of a complete termination of access to their single most critical manufacturing choke point identified in Figure 6, the most selected response was that it would slow operations for more than one year (42%), followed by slowing operations for between six to twelve months (17%).

- 26% of respondents indicated that loss of access to the single most critical choke point would cause them to cease operations for more than six months.
- Conversely only 4% indicated that such a loss of access would have no effect on their operations.

FIGURE 7

Time Delay Resulting from the Most Critical Supply Chain Disruption



Sample Size = 24

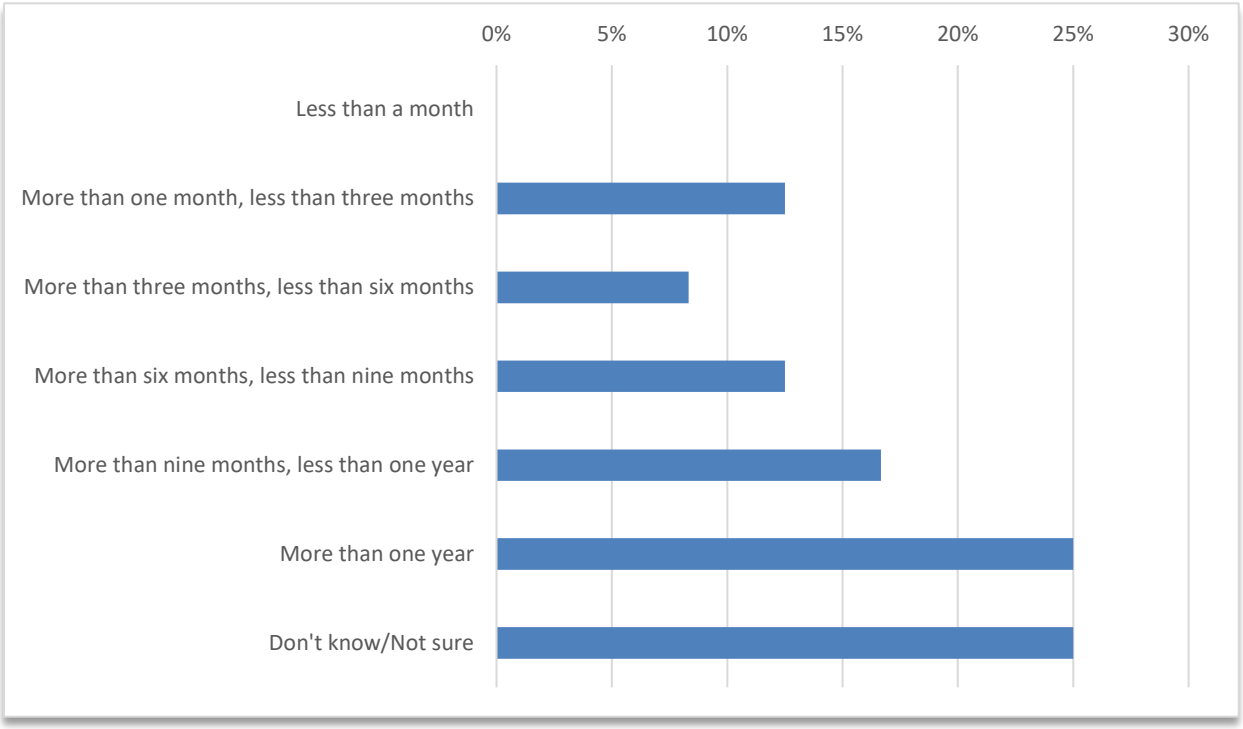
Source: Hyperion Research, 2022

When asked how long it would take their organization to find an alternate supplier for their single most critical manufacturing choke point identified in Figure 6, as seen below in Figure 8, the most selected response was more than one year (25%), followed by between nine months and one year (13%).

- No respondent selected less than one month to find an alternate supplier, and in total 75% of the respondents indicated that it would take at least one month or more.
- Fully one quarter of the respondents indicated that they either didn't know or were not sure how long it would take to find an alternate supplier. These respondents either had not yet considered contingency plans to find an alternate supplier for their most critical choke points or that they had not been able to confidently locate one.

FIGURE 8

Time Needed to Find Alternate Supplier



Sample Size = 24

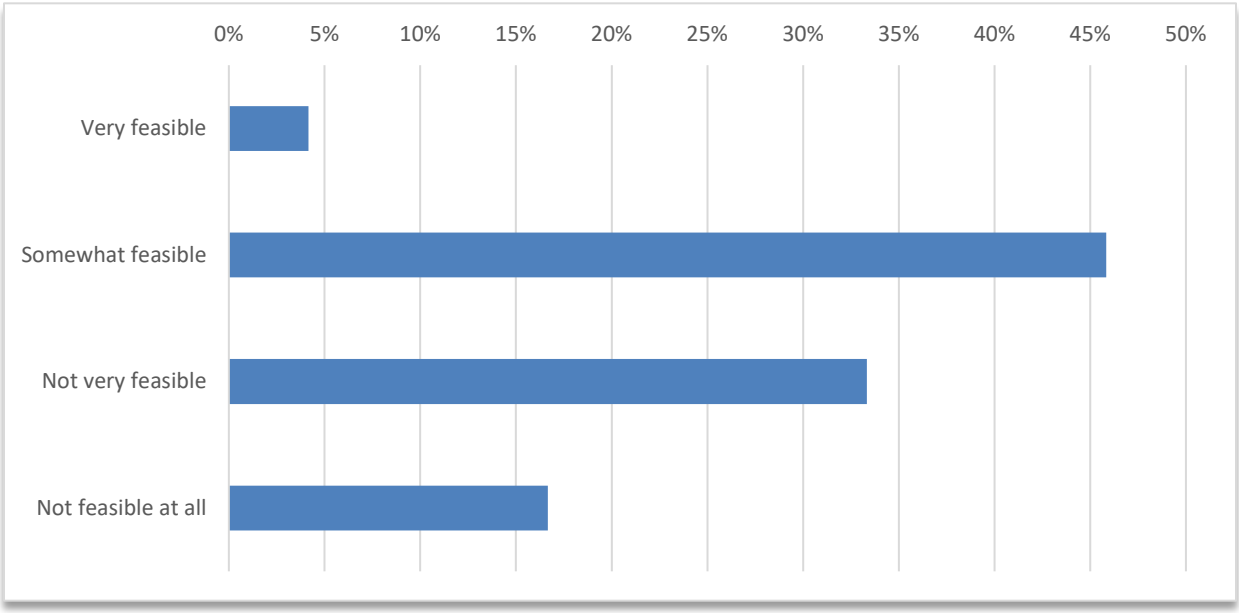
Source: Hyperion Research, 2022

Reinforcing concerns about the time needed to find a replacement for their most critical choke point identified in Figure 6, as seen below in Figure 9, the bulk of responses (46%) indicated that locating such a replacement was somewhat feasible, while one third (33%) said it was not very feasible, and 17% said it was not feasible at all.

- Only a small portion (4%) indicated that locating a replacement within their QC supply chain at their most critical choke point was very feasible.

FIGURE 9

Feasibility of Finding Replacement Capability



Sample Size = 24

Source: Hyperion Research, 2022

QC SUPPLY CHAIN ISSUES FOR QC-RELATED SOFTWARE AND/OR SERVICES

The following section narrows in on QC suppliers' concerns related specifically to QC-related software and/or services. As such, the base of respondents was confined to only those that both were involved in that part of the QC sector and that had relevant concerns with QC supply chain issues. Specifically, of the total 47 total survey respondents, 32 indicated that they were directly involved in one or more of these sectors.

- Of those 32, only 7, representing 22% of QC software and/or service providers, foresaw some form of a QC supply chain issue.
- This varies considerably from the more pessimistic 68% of respondents looking at counterpart hardware related QC supply chain issues.

Unless indicated otherwise, the sample size for this section is seven. With such a small sample size, results here will be presented in a more compact form with only minimal analysis.

- The top identified QC-related software or QC service choke points in the next three years were reliable access to either skilled domestic or foreign QC-related subject matter experts, skilled domestic QC-related applications developers, and foreign QC-related scientists for theoretical development.

- The impact of a complete termination of access to their single most critical QC-related software or QC-related service choke point would most likely slow operations for six months or more.
- Finding a suitable alternate supplier of the critical QC-related software or QC service choke point replacement would likely require three to nine months, but most respondents thought doing so would be very or somewhat feasible.

POLICY OPTIONS TO ADDRESS US QC SUPPLY CHAIN CONCERNS

The following section outlines survey results of key national-level policy initiatives that could be undertaken to address current or anticipated QC supply chain issues. Detailed results include both US and foreign government policy initiatives that are seen by respondents as being between most beneficial and most detrimental. The section concludes with a summary of the potential impact that external forces, such as rising costs of labor, construction, or energy, could have on the overall US QC supply chain. Results for this section include responses from all 47 survey participants.

As seen below in Table 4, survey respondents had strong opinions on the value of various US government policy initiatives related to QC supply chain dynamics. In general, the policy initiatives deemed most beneficial centered on increased support, both financial and technical, from the US government, while initiatives that could hinder QC supplier efforts to freely engage in a global QC ecosystem were deemed most detrimental. Specifically:

- Survey respondents considered the most beneficial US government policy initiatives to be increasing direct government funding for organization's quantum R&D (68%), improving and expanding targeted government-conducted quantum R&D programs (60%), and increasing and strengthening government R&D incentives, such as R&D tax credits, for their organization's quantum R&D expenses (57%).
- US policy options that were considered very detrimental included import/export tariffs (43%), strengthening deemed export policies (23%), and strengthening goods and services export control policies (21%).

Finally, potential US government policies that were most widely perceived as having no impact centered on financial options such as strengthening anti-trust regulations (21%), improving finance/investment regulations (20%), and improving corporate tax policy (17%). This result may speak to the relatively nascent state of many QC companies that have not yet fully matured into a stable state operating under traditional business policies and practices.

Table 4

Perceptions of US Policy Initiatives to Address QC Supply Chain Concerns

	Very Beneficial	Somewhat Beneficial	Somewhat Detrimental	Very Detrimental	No Impact
Increase direct government funding for organization's quantum R&D	68%	26%	0%	0%	4%
Improve and expand targeted government-conducted quantum R&D programs	60%	32%	0%	2%	4%
Increase and strengthen government R&D incentives, such as R&D tax credits, for organization's quantum R&D expenses	57%	40%	0%	0%	0%
Increase domestic industry consortium funding/support	47%	45%	0%	2%	2%
Strengthen international cooperation support	45%	34%	6%	2%	9%
Improve and expand targeted government-sponsored quantum R&D programs at third-party research centers such as universities	40%	49%	4%	2%	4%
Strengthen IP/Patent protection	34%	36%	11%	0%	4%
Strengthen government procurement policies	28%	36%	6%	6%	9%
Strengthen standards and benchmarking activities	27%	47%	4%	0%	16%
Strengthen "favored industries" policies	21%	40%	9%	4%	2%
Improve corporate tax policy	17%	40%	4%	0%	17%
Improve finance/investment regulations	15%	26%	11%	4%	20%
Strengthen anti-trust regulations	13%	17%	15%	13%	21%
Strengthen goods and services export control policies	4%	13%	28%	21%	11%
Strengthen deemed export policies	2%	17%	21%	23%	4%
Increase import/export tariffs	0%	6%	19%	43%	9%

Note: Sample Size = 47

Source: Hyperion Research, 2022

Table 5 below summarizes survey respondents' perceptions of foreign (non-US) government policy initiatives that could either help or hinder their organizations' prospects for a secure QC supply chain. The results here largely mirror the opinions expressed above for US policy initiatives but include a few differences.

- US QC suppliers were slightly less positive about any foreign vs US government efforts to support their domestic QC sector either through government funding of commercial R&D or government conducted QC-related research.
- In contrast, respondents considered foreign government efforts to strengthen support to international cooperation as beneficial.
- Likewise, similar to counterpart policy initiatives in the US, any policies that could curtail the import of US-origin QC goods and services were deemed as detrimental.

Table 5

Perceptions of Foreign Policy Initiatives That Could Affect US QC Supply Chains

	Very Beneficial	Somewhat Beneficial	Somewhat Detrimental	Very Detrimental	No Impact
Increase direct government funding for organization's quantum R&D	53%	32%	2%	0%	2%
Strengthen international cooperation support	47%	32%	4%	0%	2%
Improve and expand targeted Government-conducted quantum R&D programs	45%	36%	4%	2%	2%
Improve and expand targeted Government-sponsored quantum R&D programs at third-party research centers such as universities	43%	30%	6%	2%	2%
Increase and strengthen government R&D incentives, such as R&D tax credits, for organization's quantum R&D expenses	36%	36%	4%	0%	4%
Strengthen standards and benchmarking activities	35%	33%	4%	0%	7%
Increase domestic industry consortium funding/support	32%	40%	4%	0%	2%
Strengthen IP/Patent protection	21%	38%	15%	2%	0%
Strengthen government procurement policies	15%	26%	13%	0%	4%
Improve finance/investment regulations	11%	23%	9%	0%	11%
Improve corporate tax policy	11%	28%	9%	0%	17%
Strengthen "favored industries" policies	9%	37%	7%	2%	7%

Strengthen anti-trust regulations	9%	13%	17%	6%	17%
Strengthen goods and services export control policies	2%	17%	22%	20%	7%
Strengthen deemed export policies	0%	11%	23%	17%	4%
Increase import/export tariffs	0%	2%	26%	46%	2%

Note: Sample Size = 47

Source: Hyperion Research, 2022

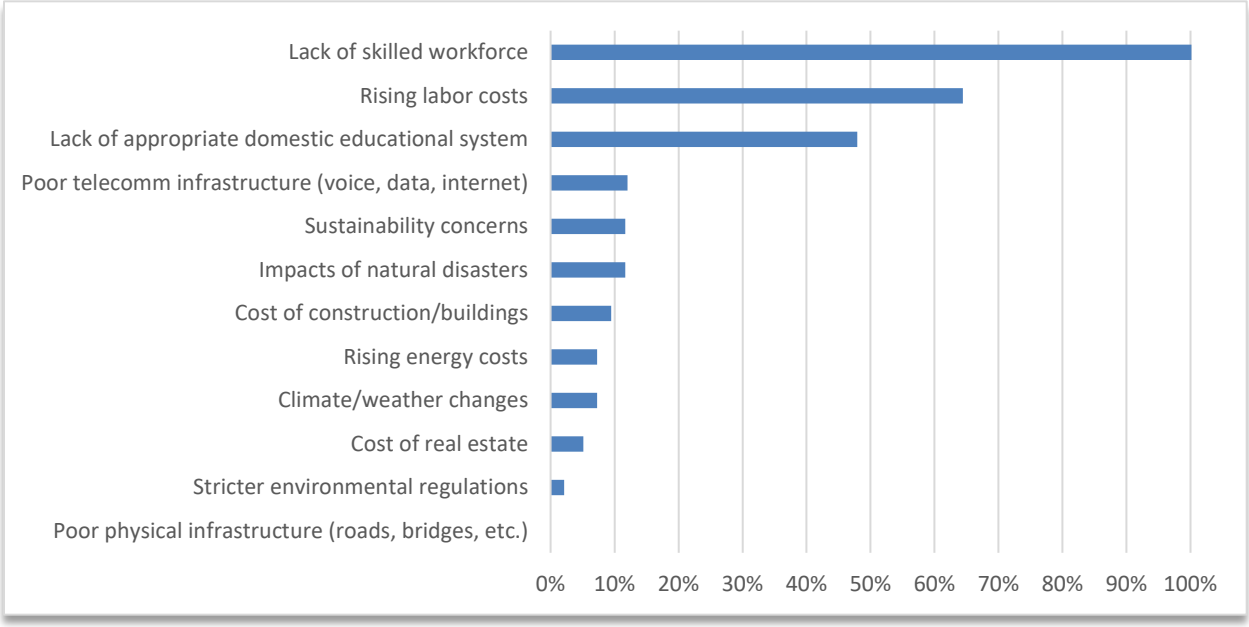
Figure 10, below, arrays survey respondents' perceptions of external forces that could have an impact on the overall robustness of the US QC supply chain. Respondents were allowed to select up to three choices.

Every respondent in the survey (47 out of 47) selected the lack of a skilled workforce as one of the top three external forces that could negatively impact the US QC supply chain. This, combined with concomitant issues with rising labor costs and a lack an appropriate domestic education system, imparts a strong indication about both current and future concerns of the US QC supply base to train, employ, and retain the necessary skilled workforce.

- Additional external forces, albeit not a top priority, but still mentioned by some, include a poor telecommunication infrastructure and sustainability concerns.

FIGURE 10

External Forces That Could Create US QC Supply Chain Issues



Note: Sample size = 47, Respondents could select up to three choices

Source: Hyperion Research, 2022

SUMMARY AND SUGGESTED FOLLOW-ON ACTIVITIES

Based on the results of this survey, there are significant concerns within the QC supplier ecosystem that there could be a serious supply chain disruption in the next few years. Potential areas of concern are widely dispersed across the supply chain spanning assured access to necessary raw materials to a steady supply of trained software experts. Further complicating this issue is that the QC sector is currently in a nascent and rapidly changing state, with a spate of new technologies, hardware and software implementations, and related production and distribution schemes yet to be firmly established. The QC sector writ large will likely remain fluid for at least the next few years, and the establishment of a well-defined, complete, and stable supply chain for the sector will remain in flux for at least as long, if not longer.

Owing to the broad range of QC supply chain concerns, US policy options to eliminate, or even lessen, the specter of any significant QC supply chain disruptions are likely neither clear nor reducible to a one size fits all solution. Ultimately a comprehensive range of mutually reinforcing initiatives will be needed to adequately secure all aspects of the US QC ecosystem. At the same time, these programs, as is typical for any critical advanced technology, must address key US government use cases for the technology while also furthering the overall and global competitive ability of its domestic commercial sector.

Perhaps equally important is the reality that any US government policy initiatives will likely need to acknowledge that there are significant, if not at parity, QC-related government development programs and related commercial efforts being actively pursued by a number of foreign countries. The US commercial information technology sector does not hold any significant legacy advantage from its long history of world-class capability in classical computing and is instead competing in the QC space on a level playing field with a number of regions, counties, and commercial competitors on a global front. Likewise, numerous foreign national-level QC promotion policies are broad, supporting QC development for national security agenda requirements, enabling a strong domestic QC ecosystem, and empowering a wide range of commercial sectors seeking to enhance their global competitiveness as a QC end user.

Faced with this broad range of QC sector realities, there are a number of key considerations relevant to any future US government policy action.

Continual tracking of the overall dynamics of the US QC supply chain will be needed to identify the most critical vulnerabilities from either domestic or foreign sources, especially as the current QC supply chain is continually shifting with new vulnerabilities rising and falling as the technology evolves. Managing the everchanging state of the overall QC supply chain, from both a supply and demand perspective, will be complex as some elements within the current QC supply chain, especially the materials, components, and sub subassembly suppliers, see QC as only a small part of their overall consumer base. As such, US policy makers charged with protecting the US QC supply chain need to ensure that any QC-related policies do not contravene the overall competitive position of key supply chain participants.

Continued US government support to the sector in the form of research partnerships, direct R&D funding, or targeted strategic procurements will be critical for at least the next few years. The QC sector writ large is still in an emerging state whereby funding for both advanced research and product developments come not from existing sales but external funding mechanisms including corporate and venture capital sources as well as government programs. These efforts have and will continue to be

instrumental in enabling a competitive US QC sector, relying to a great extent on US government technology promotion polices that are flexible to new technology developments, encourage innovation and collaboration across the US QC community, and, perhaps most important, establish a visible commitment to long-term funding, either through conducting direct R&D or funding outside commercial activities. Such confidence building measures will be instrumental in maintaining or even increasing QC-related funding from the commercial sector while demonstrating to the large pool of potential QC end users that QC technology will soon evolve into a stable, mature, and economically beneficial market sector.

Finally, careful monitoring of foreign QC commercial and government efforts to foster a strong domestic and independent QC ecosystem should be an integral part of any US QC policy package, particularly in those countries with national security agenda concerns. Such foreign efforts become even more critical in cases where foreign policies, either deliberately or as an unintended side effect, have a detrimental effect on the US QC commercial sector's ability to compete fairly in that country or region. Critical policy actions identified in the survey as being most detrimental to the US QC sector centered on those designed to limit or otherwise raise the cost of importing US origin QC good and services. US QC suppliers are also concerned, albeit to a lesser extent, with foreign government efforts to support their domestic QC sector through either government funding of commercial R&D or government conducted QC-related research.

About the Quantum Economic Development Consortium

The Quantum Economic Development Consortium (QED-C) is an industry-driven consortium managed by SRI International. The consortium seeks to enable and grow the quantum industry and associated supply chain. QED-C is supported by the National Institute of Standards and Technology (NIST) in the U.S. Department of Commerce and about 200 members, including component manufacturers and suppliers, software and hardware system developers, researchers, professional service providers, and end users. Consortium membership represents companies, universities, federally funded research and development centers, government, and other stakeholders. Learn more about QED-C at quantumconsortium.org.

About Hyperion Research, LLC

Hyperion Research provides data-driven research, analysis and recommendations for technologies, applications, and markets in high performance computing and emerging technology areas to help organizations worldwide make effective decisions and seize growth opportunities. Research includes market sizing and forecasting, share tracking, segmentation, technology, and related trend analysis, and both user & vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). We provide thought leadership and practical guidance for users, vendors, and other members of the HPC community by focusing on key market and technology trends across government, industry, commerce, and academia.

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