HYPERION RESEARCH

ROBUST EXPLORATION AND GROWING USE OF BUSINESS PROCESS OPTIMIZATION USING QUANTUM COMPUTING

Sponsored by D-Wave Quantum

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EXECUTIVE SUMMARY

Hyperion Research, in conjunction with D-Wave Quantum Inc. ("D-Wave"), a leader in quantum computing systems, software, and services and the world's first commercial supplier of quantum computers, recently conducted a study to better understand the challenges and opportunities experienced by commercial end users currently exploring the optimization of key business processes using quantum computing ("QC"). Integral to this effort was a survey of over 300 organizations in the United States and select European countries that were concurrently exploring or planning to explore with the next 12-18 months, QC-based optimization techniques to address their most pressing business processes across a range of key verticals. These included automotive/transportation/mobility, chemicals, financial or financial service, oil & gas, software & internet, and telecommunications.

Key findings of the study:

QC-based optimization is deemed important by almost all. First and foremost, survey respondents overwhelmingly indicated that QC-based optimization capabilities are seen as integral to optimizing their key business processes. Some 61% of respondents saw QC-based optimization as being very important to improving the performance of their key business processes, and 36% saw it as somewhat important. In contrast, only about 1% saw QC-based optimization as either unimportant or too early to make an informed decision.

The potential of QC-based optimization spans a wide range of business processes. When asked about the single most important business process appropriate for QC-based optimization, respondents' top choices were finance-oriented optimization (17%), supply chain management (16%), and manufacturing/factory processes (14%). However, for each of the ten offered business processes, which also included workflow schedules, sales/marketing strategy, logistics, and maintenance planning, every option was selected by some organizations as the most important business process that could be enhanced by QC-based optimization.

Most organizations already have or will soon have active QC-based optimization efforts underway. The predominant QC-based optimization efforts currently underway or planned within the next 12-18 months were considering options and monitoring technology development (59%), conducting quantum use case analysis and prioritization (52%), and engaging in production use of quantum computing for one or more business processes (49%). Respondents could select all options that applied, and the average respondent selected 2.6 current or planned QC-based optimization efforts, indicating that most organizations have a number of different efforts underway, likely at different stages of maturity.

Persuasive business drivers are spurring QC-based optimization efforts. The three most important business drivers for QC-based optimization development were increasing revenue (55%), enhancing business process efficiency (53%), and realizing cost saving (50%). Respondents could select as many options as applicable, and the average respondent selected 3.4 drivers, signaling, perhaps, a broad range of perceived business-related benefits from QC-based optimization efforts. Driving innovation (45%) and improving research capabilities (42%), although not considered traditional core business processes, were still cited as being important business drivers by many.

- The most important drivers for what the respondents deemed to be their most important QC-based optimization efforts were enhancing business process efficiencies (24%), increasing revenue (20%), and driving innovation (14%).

Key organizational drivers contribute to QC-based optimization efforts. The key organizational driver for exploring QC-based optimization was potential performance improvements in key workloads, strongly backed by the influence from technical/IT staff and upper-level management.

- In general, this result fits the overall findings of this study that center on key business process improvements over an emphasis on research and innovation, highlighting pragmatic and commercial-oriented expectations for the technology.

Despite widespread enthusiasm for QC-base optimization, underlying hurdles are lurking. There was no dominant hurdle that QC-based optimization developers needed to overcome, but instead they identified a swath of concerns, suggesting that there is no single solution to mitigate the QC-optimization process. Leading hurdles identified included complexity with integrating into existing infrastructure, a lack of an in-house QC expertise, and concerns with demonstrating ROI. Other hurdles identified included a lack of available funding, unproven performance advantages over classical counterparts, concerns with overall near-term prospects for the QC sector, and limited QC vendor options.

- Generally, however, many of these concerns are typical among the end user community in the early stages of a new technology rollout and similar to what was in previous technology advances, including classical HPC multiprocessors designs, CPU to GPU conversion, AI for science and engineering, and now QC.

Significant funding is allotted for maintaining an eventual steady state QC-optimization operation. When asked about their organization's long-term annual budget commitment once a fully capable QC-based optimization program was established, the most selected options were US$1,000,000 to less than US$5,000,000 (18%), US$5,000,000 to less than US$7,500,000 (14%), and US$500,000 to less than US$750,000 (12%). These budget numbers represent total end user spending on QC-based optimization operations that include both QC supplier base revenues as well as the organization's in-house costs.

There were high expectations for substantial return on investment (ROI) driven by steady state QC-based optimization operations totaling more than US$50 billion for the 290 firms that responded to this question. This data-driven estimate, which considers only a subset of the overall business community likely to adopt quantum optimization, provides a glimpse into the ultimate potential of this technology to drive significant business growth and value creation across industries.

- Detailed survey respondents' selections for the long-term annual expected ROI due to having a QC-based optimization operation centered on US$25 million to less than US$100 million (20%), US$10 million to less than US$25 million (16%), and US$5 million to less than US$10 million (15%).

High returns on investment (ROI) expectations on budget commitments are anticipated, approaching up to 20x, for supporting a QC-based optimization operation. When correlating respondent organizations' long-term annual commitment to QC-based optimization operations with that organization's expected ROI, due to a combination of factors that include greater operational efficiencies, increased revenue, increased competitive advantage and realized cost savings as a result of those operations, the most frequent outcome was US$3-6 million expenditures with resulting ROI of US$60-65 million, representing an estimated ROI of up to 20x of the initial investment.

- One out of ten respondents expected annual QC-based optimization budgets to exceed US$27 million, while expecting an annual ROI of US$376 million to over US$1 billion.

A wide base of commercial organizations are actively exploring the potential performance and financial advantages of integrating QC-based optimization into their overall computational environment. This study concentrated on the commercial and business potential of quantum computing and ended up gathering data primarily from respondents of organizations that self-identify as a mixed enterprise High Performance Computing (HPC) environment, which are sites that many do not associate with the aggressive adoption of nascent and rapidly evolving emerging technologies, which could be interpreted as making the results all the more compelling.

Indeed, this study highlights that the surveyed commercial organizations are largely optimistic that the capabilities of current and near-term quantum systems are capable of supporting critical business processes that can significantly increase their overall competitiveness. As such, these organizations are committing substantial funds to explore opportunities, and based on their responses, appear likely to continue to refine their capabilities, ultimately moving a range of QC-based optimization processes into their overall business operations.

These respondents' expectations are high for the financial benefits of such operations, and, for its part, it appears that the overall quantum computing supplier base can only benefit from offering improved capabilities for key commercial-oriented optimization processes.

- However, commercial end users will be carefully looking to that QC supplier base for better ways to address concerns such as complexities with integrating QC capabilities into classical ecosystems, from both a hardware and software perspective, navigating a lack of in-house end user expertise, unclear vendor selection criteria, and larger issues with the long-term viability of the sector.
- Vendors that can most effectively mitigate these shortcomings appear to stand the best chance of achieving significant success in quantum optimization, a rapidly growing and, perhaps more important, most promising near-term segment of the overall QC market.

OVERVIEW

Hyperion Research, in conjunction with D-Wave, a leader in quantum computing systems, software, and services and the world's first commercial supplier of quantum computers, recently conducted a survey to better understand the challenges and opportunities experienced by commercial end users exploring or planning to explore the optimization of key business processes using quantum computing.

- For the purpose of this study, optimization efforts under consideration were those targeted to directly support an organization's capabilities to offer key revenue-generating products and/or services.

Ultimately, the goal of this effort was to better understand the status, variety, and span of optimization efforts using QC capabilities across a wide range of QC end users, as well as gauge the range of key business processes, business considerations, and organizational drivers of QC-related optimization efforts.

This study draws heavily on the results of a Hyperion Research-directed survey sent to a wide and diverse base of commercial organizations currently involved in or planning within the next 18 months to explore various aspects of QC-base optimization efforts. The survey, which was conducted between April 12, 2024 and May 28, 2024, collected responses from 303 organizations after reaching out to 695 potential respondents, a 43% completion rate.

In order to concentrate on organizations with annual revenues and related IT budgets sufficient to commit the resources needed to adequately explore QC technology, survey participation was limited to those organizations with at least an estimated US$15 million in 2024 total revenues and overall estimated IT 2024 budgets of US$5 million or more.

- By design, geographic location of the survey respondent's headquarters centered on Europe and the United States, with the most representation from the US (48%), followed by respondents in Germany (15%), France, (12%), the United Kingdom (10%), Italy (8%), and Spain (8%).

The study covered a wide range of verticals, 18 in total, broken down into two groups: target industries and secondary industries.

Target Industries: The following ten industries were considered by Hyperion Research to be the most likely to be interested in QC-based optimization efforts. This group comprised 237 of the 303 total respondents (78%).

- Automotive/Transportation/Mobility
- Chemicals
- Financial or Financial Services
- Healthcare
- Insurance
- Manufacturing
- Oil & Gas
- Retail/e-commerce
- Software & Internet

■ Telecommunications

Secondary Industries: This vertical included those not expressly within the targeted industries group. This group comprised 66 of the 303 total respondents (22%).

- ■ Advanced Manufacturing
- ■ Aerospace
- ■ Bio-sciences
- ■ Computer-aided Engineering
- ■ Logistics
- ■ Other (self-identified primarily as Information Technology)
- ■ Quantum Computing, Computers, Electronics, and Optical Products
- ■ Telecommunications

For this effort, financial or budgetary statistics were collected in the appropriate currencies (dollar, euro, or pounds), and conversions were used depending on country of respondent. However, all financial numbers here are presented in US$.

SUBSTANTIAL COMMERCIAL ACTIVITY AND INTEREST IN EXPLORING QC-OPTIMIZATION TO ADDRESS KEY BUSINESS PROCESSES

Hyperion Research survey results indicate that there already are a wide range of commercial organizations engaged in some form of QC-based optimization exploration efforts. The following section identifies the current level of ongoing QC efforts within those QC-based optimization developers and provides some key demographics of the survey respondent organizations. (See the Appendix for additional demographic information on the surveyed organizations.)

First and foremost, respondents overwhelmingly indicated that QC-based optimization capabilities are seen as integral to optimizing key business processes, both within the target and secondary industries, as seen in Figure 1. Some 61% of respondents saw QC-based optimization as being very important to improving the performance of their key business processes, and 36% saw it as somewhat important. In contrast, only about 1% saw QC-based optimization as either unimportant or too early to make an informed decision.

- ■ There was some variation in optimism for the capability from a country perspective. For example, 70% of US-based respondents companies saw QC optimization as very important, the highest of any surveyed country, compared with only 43% of German counterparts, the lowest.

FIGURE 1

QC-Based Optimization: Integral to Optimizing Key Business Processes
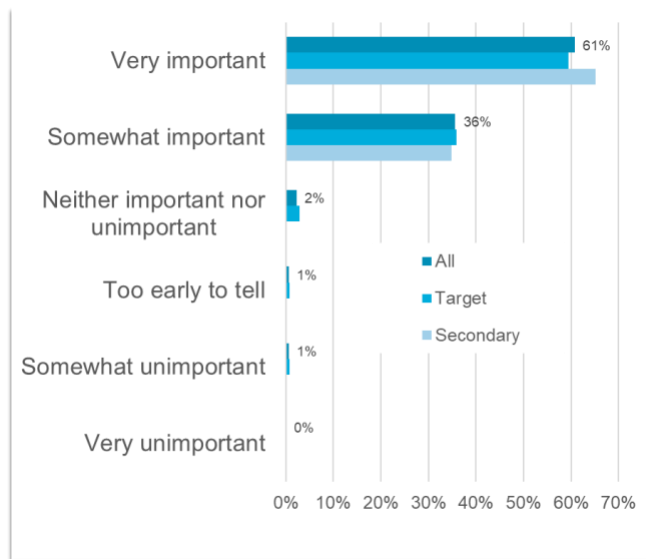
All= 303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

As seen in Figure 2, when asked to identify the predominant QC-based optimization efforts currently underway or planned to be underway within the next 12-18 months, the majority of respondents indicated that their organization was considering options and monitoring technology development (59%), conducting quantum use case analysis and prioritization (52%), and engaging in production use of quantum computing for one or more business processes (49%). Respondents could select all options that applied, and the average respondent selected 2.6 current or planned QC-based optimization efforts, indicating that most organizations have more than one parallel effort underway, likely at different stages of development.

- Despite nearly half of all respondents indicating they had on-going or planned QC-based optimization efforts, those are likely limited efforts supplemental to existing business processes and not yet tightly integrated into the organization's overall comprehensive business operations, at least for the near term.

FIGURE 2

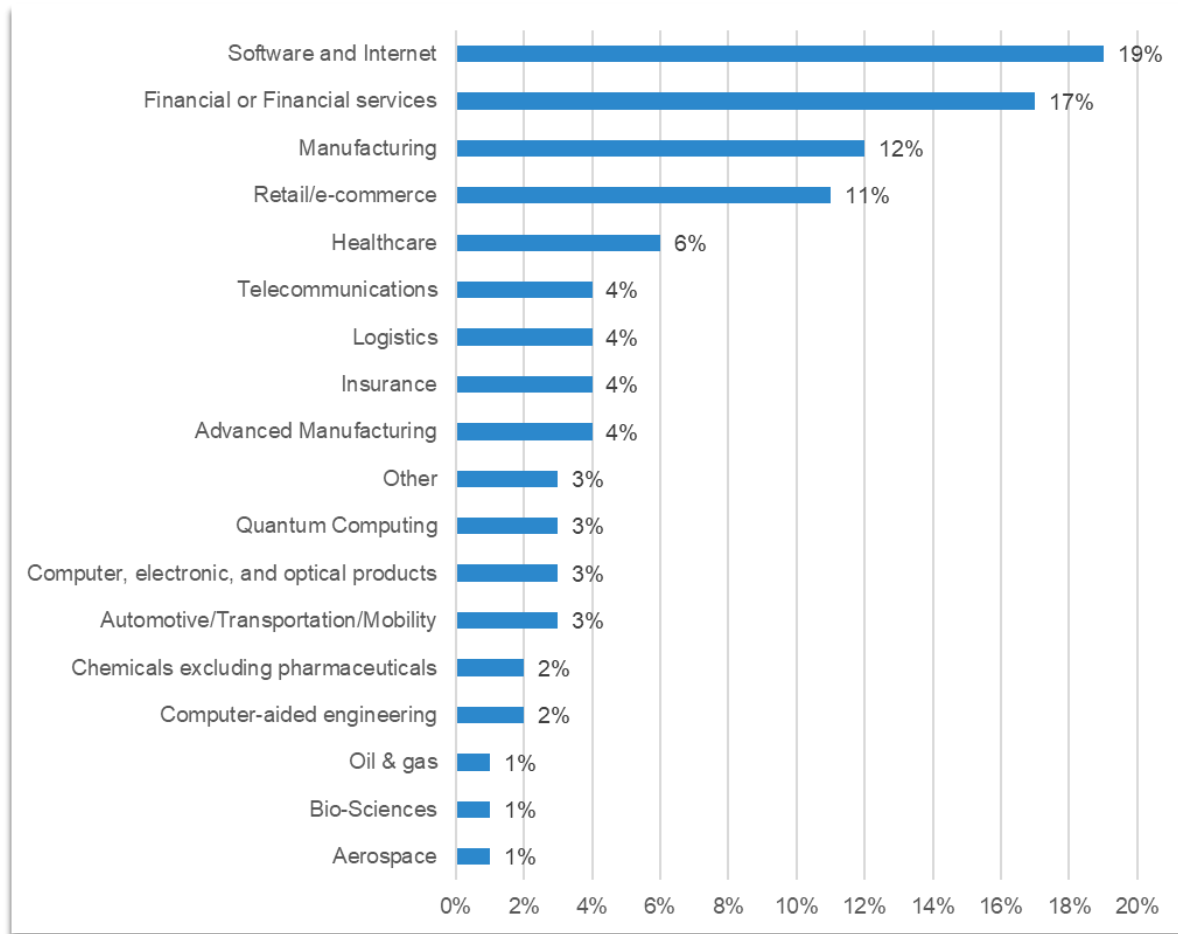## Span QC-Related Activities to Address Key Business Processes

	All	Target	Secondary
Considering options and monitoring technology development	59%	57%	64%
Quantum use case analysis and prioritization	52%	51%	53%
Production use of quantum computing for one or more business processes	49%	49%	48%
Proof of concept research program	39%	38%	41%
Fully funded research effort	35%	34%	36%
Limited in-house pilot program	30%	33%	21%

Note: Respondents could select all options that apply

N= 303, Target= 237, Secondary= 66

Source: Hyperion Research, 2024

As seen in Figure 3, which breaks down the list of survey respondents by their organization's main area of activity, the largest group of respondents represented the software and internet sector (19%), followed by financial or financial services (17%), and manufacturing (12%). Although the overall sample size is not large enough to support detailed analysis of any one sector, the range of responses across these different verticals is a strong indication as to the wide commercial interest in QC-based optimization.

FIGURE 3

QC-Based Optimization Developers' Line of Business

Software and Internet — 19%
Financial or Financial services — 17%
Manufacturing — 12%
Retail/e-commerce — 11%
Healthcare — 6%
Telecommunications — 4%
Logistics — 4%
Insurance — 4%
Advanced Manufacturing — 4%
Other — 3%
Quantum Computing — 3%
Computer, electronic, and optical products — 3%
Automotive/Transportation/Mobility — 3%
Chemicals excluding pharmaceuticals — 2%
Computer-aided engineering — 2%
Oil & gas — 1%
Bio-Sciences — 1%
Aerospace — 1%

N = 303

Source: Hyperion Research, 2024

As seen in Figure 4, when asked to characterize the current classical (non-QC) computing environment of their organization, there was a wide range of HPC and enterprise-based complements but with a decided emphasis on enterprise. Indeed, 60% of respondents indicated that their organization was either a mixed or primary enterprise shop, while 38% of the respondents' organization were considered to be either primarily HPC research or HPC production shops.

Despite that many see quantum computing as targeted primarily for advanced computing facilities that rely on cutting-edge computational capabilities typical at HPC research facilities, it is not surprising the high degree of interest by enterprise organizations in this particular study. Given the study explored key business processes – which are critical to commercial organizations – those are not a high priority to committed HPC counterparts.

- There was little representation (3%) from enterprise IT shops that had no HPC capabilities, suggesting that computing environments with little or no HPC capabilities are unlikely to be QC-based optimization developers.

FIGURE 4

QC-Based Optimization Developers: High Interest Within the Enterprise

	All	Target	Secondary
Primarily high-performance computing (HPC) research environment	16%	12%	27%
Primarily high-performance computing (HPC) production environment	22%	22%	24%
A mixed high-performance computing (HPC) and enterprise environment	47%	50%	36%
Primarily an enterprise IT shop with some high-performance computing (HPC) or related computational research capabilities	13%	14%	11%
Primarily an enterprise IT shop with no high-performance computing (HPC) or related computational research capabilities	3%	3%	2%

N= 330. Target= 237, Secondary = 66

Source: Hyperion Research, 2024

DRIVERS AND MOTIVATORS FOR QC-BASED OPTIMIZATION DEVELOPERS

One of the goals of this study was to better understand some of the key influences and motivations of QC-based optimization developers. The following section highlights the various value and organizational opportunities engendered by QC-based optimization adoption as well as expectations for the most promising workloads.

As seen in Figure 5, when asked to cite the range of important business processes appropriate for QC-based optimization within their organization, respondents' top choices were supply chain management (45%), workflow schedules (45%), and manufacturing/factory process (42%). However, additional options that were selected by at least one-third of the respondents included finance-oriented optimization (41%), maintenance planning (38%), sales/marketing strategy (38%), logistics (38%) and inventory management (36%).

- The average respondent selected 3.7 options, suggesting that surveyed organizations see a broad range of QC-based optimization potential, and that combined with the results outlined in Figure 2, highlighted a range of ongoing QC-based optimization efforts. Many of these identified processes may already be undergoing some form of QC-based optimization development or will within the next 12-18 months.

FIGURE 5

Business Processes Appropriate for QC-Based Optimization

	All	Target	Secondary
Supply chain management	45%	45%	44%
Workflow schedules	45%	45%	44%
Manufacturing/factory processes	42%	45%	30%
Finance-oriented optimization	41%	43%	32%
Maintenance planning	38%	36%	45%
Sales/marketing strategy	38%	41%	27%
Logistics	38%	37%	39%
Inventory management	36%	37%	35%
Staffing schedules	31%	30%	36%
Transportation including vehicle routing	20%	21%	18%

N=303, Target= 237, Secondary = 66

Note: Respondents could select all options that apply

Source: Hyperion Research, 2024

When asked about the single most important business process appropriate for QC-based optimization shown in Figure 6, respondents' top choices were finance-oriented optimization (17%), supply chain management (16%), and manufacturing/factory processes (14%). However, for each of the ten offered business processes, at least five or more respondents chose that option as the most important.

There was little variation in the most important business processes for QC-based optimization between the target and secondary industries surveyed, but from a country perspective, the United Kingdom (UK) registered zero responses for manufacturing/factory processes, the lowest of any surveyed nation,. However, UK organizations showed the highest interest in finance-oriented optimization of any nation (31%).

- In contrast, Germany had highest interest in manufacturing/factory processes (20%) and workflow schedules (20%).

FIGURE 6

Single Most Important Business Process Appropriate for QC-Based Optimization

	All	Target	Secondary
Finance-oriented optimization	17%	20%	5%
Supply chain management	16%	16%	17%
Manufacturing/factory processes	14%	14%	17%
Workflow schedules	12%	10%	20%
Sales/marketing strategy	12%	13%	8%
Logistics	9%	9%	6%
Maintenance planning	8%	7%	14%
Inventory management	8%	8%	6%
Staffing schedules	4%	3%	6%
Transportation including vehicle routing	2%	1%	3%

N= 303, Target = 237, Secondary = 66

Source: Hyperion Research, 2024

Unlike Figure 2, which shows the entire range of ongoing QC-based optimization activities within respondents' organizations, Figure 7 summarizes the status of the single most important QC-based optimization activity currently or within the next 12-18 months. Here, one quarter of the respondents (25%) indicated that their organization was conducting quantum use case analysis and prioritization and one-fifth of the respondents indicated production use QC-based optimization process (21%) or considering options and monitoring technology developments (20%).

- French respondents were the most aggressive in implementing production use of QC-based optimization activities (25% of respondent organizations) with the UK-based respondents being the lowest (17%).

FIGURE 7

Status of Most Important QC-Based Optimization Activity Currently or Within the Next 12-18 Months
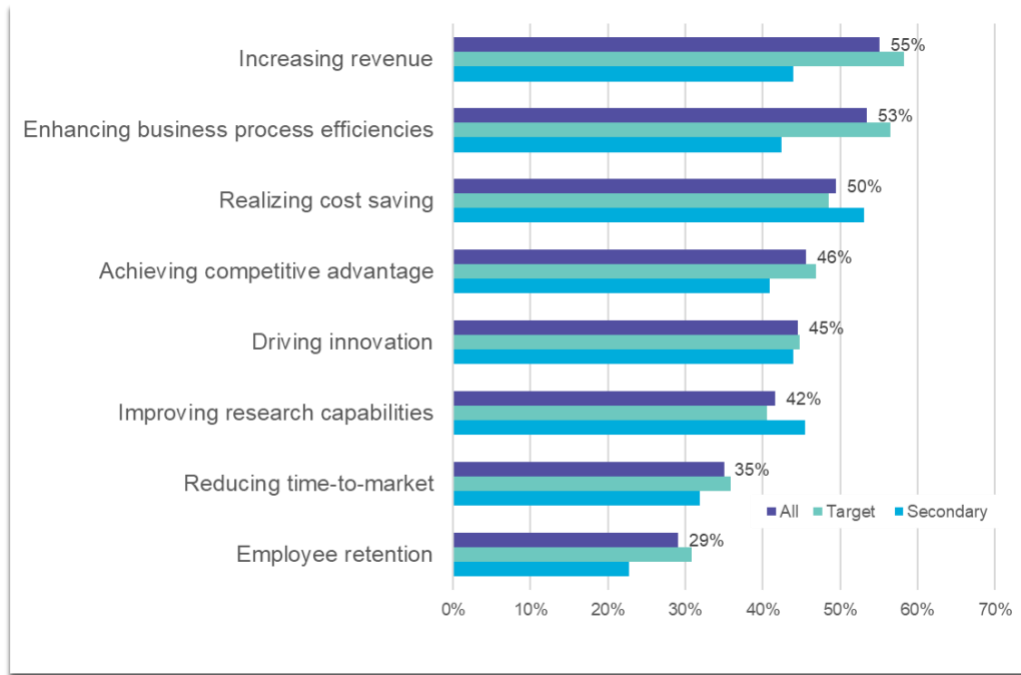
	All	**Target**	**Secondary**
Quantum use case analysis and prioritization	25%	24%	27%
Production use of quantum computing	21%	22%	20%
Considering options and monitoring technology development	20%	19%	24%
Fully funded research effort	16%	15%	18%
Proof of concept research program	10%	10%	8%
Limited in-house pilot program	8%	9%	3%

N =303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

Survey respondents indicate that the three most important business drivers for QC-based optimization development were increasing revenue (55%), enhancing business process efficiency (53%) and realizing cost saving (50%), as seen in Figure 8. Respondents could select as many options that applied, and the average respondent selected 3.4 drivers, signaling, a broad range of perceived business-related benefits from QC-based optimization efforts.

- Driving innovation (45%) and improving research capabilities (42%), although not considered core business processes, were still cited as an important business driver by many.

FIGURE 8

Span of Business Drivers for QC-Based Optimization Efforts

N= 303, Target = 237, Secondary = 66

Note: Respondents could select all options that apply

Source: Hyperion Research, 2024

Figure 9 highlights respondents' single most important driver for QC-based optimization efforts, identifying enhancing business process efficiencies (24%), increasing revenue (20%), and driving innovation (14%) as the top drivers. When considered exclusively as the single most important driver, employee retention (6%) and reducing time-to-market (3%) dropped significantly from its higher rating seen in Figure 8, where respondents could select all options that applied.

- There was some degree of variety from a country perspective: Respondents in France were the most interested in enhancing business process efficiencies (34%), with the UK-based respondents being the lowest (10%) and the US-based respondents in the middle (23%).

FIGURE 9

Single Most Important Business Driver of QC-Based Optimization Efforts
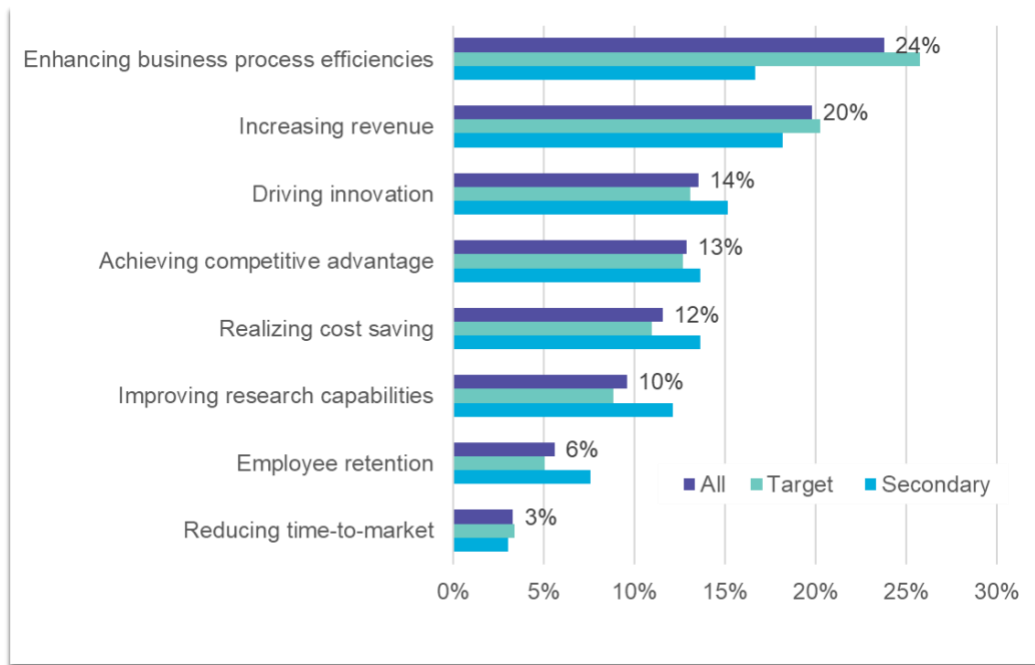
N= 303, Target= 237, Secondary= 66

Source: Hyperion Research, 2024

Figure 10 below summarizes respondents' perspectives on the organizational drivers that resulted in QC-based optimization efforts, listing all pertinent drivers as well as the single main driver. In both cases, the emphasis was on potential performance improvements in key workloads, backed by the influence from technical/IT staff and upper-level management.

- In general, the overall findings of this study center on key business process improvements over an emphasis on research and innovation, highlighting pragmatic and commercial-oriented expectations for the technology.

FIGURE 10

Organizational Drivers of QC-Based Optimization Efforts

	Driver(s)	Main Driver
Potential performance improvements on key existing workloads	46%	17%
Strong internal influence from technical/IT staff	39%	16%
Strong internal influence from upper-level management	32%	10%
Potential access to new quantum specific applications	35%	9%
Strong internal influence from business staff	26%	8%
Traditional early adopter attitude	24%	7%
Strong internal influence from scientific/research/end-user staff	25%	7%
Concerns with slowing capabilities in traditional compute solutions	31%	5%
Strong internal influence from business management	32%	5%
Fear of missing out	19%	3%

N= 303, Target= 237, Secondary= 66

For Driver(s), respondents could select all that apply; for main driver, respondents could select only one choice.

Source: Hyperion Research, 2024

QC-BASED OPTIMIZATION EFFORTS: DIVING INTO THE TECHNICAL SPECIFICS

The following section explores technical details about respondent organizations' current QC-based optimization activities, including the start date of their most important QC-based optimization effort, their current or anticipated QC hardware access method, their requirements for classical hardware support, and the greatest hurdles encountered to date.

Figure 11 shows the start date of a respondent organization's most important optimization effort, with 53% having been initiated within the last 6-18 months, and 13% underway for more than two years. Only about 15% of surveyed organizations have not yet initiated their most important QC-based optimization effort, but most intend to within the next 12 months.

- These results reveal that 85% of the most important QC-based optimization efforts within the surveyed organizations are already underway in some form or another.

- The data also reveals that within the set of surveyed organizations, roughly 60 of the 303 surveyed organizations (~20%) initiated a QC-based optimization effort in every six-month interval going back the last two years.

FIGURE 11

Start Date of Most Important QC-Based Optimization Effort
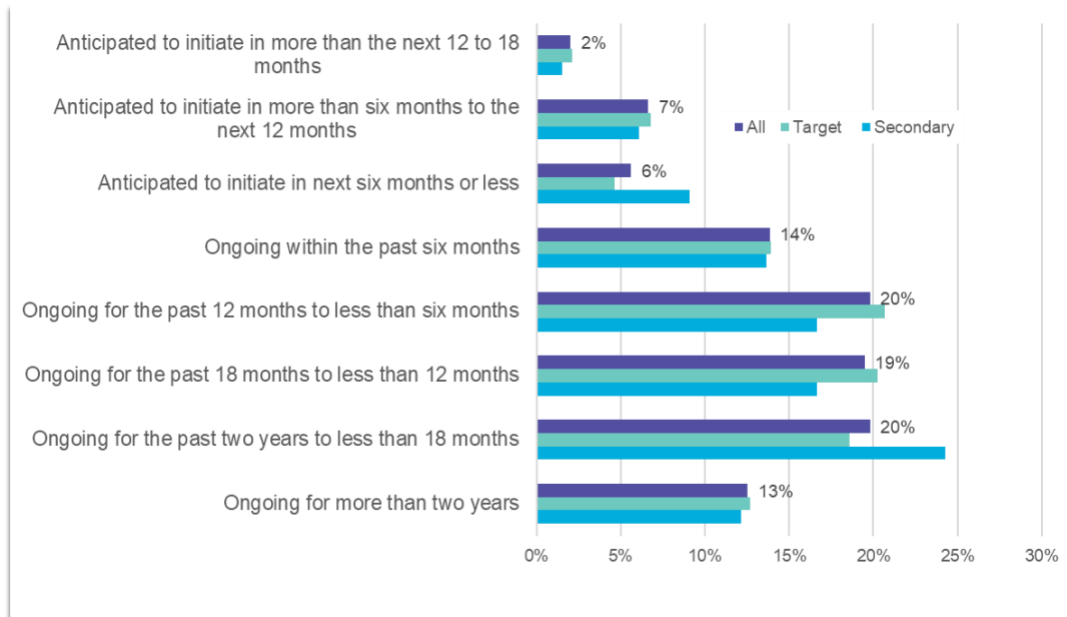
N=303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

Figure 12 lists the QC hardware access method selected to support the most important QC-based optimization efforts. The leader was cloud access provided through a cloud service provider (CSP) to a QC hardware supplier (39%), followed by direct cloud access provided by a QC hardware supplier (24%), and on-premises QC system (18%). Overall, and at least for the near-term, the bulk of surveyed organizations' QC hardware access will be through some form of a cloud access model, primarily through a CSP, most of which offer access to a range of QC hardware suppliers.

On-premises QC systems, selected by 18% of survey respondents, likely do not represent the state of QC-based optimization efforts, as there is currently only a small base of on-premises installations.

- This choice likely refers to cases where future, more stable, and likely single vendor QC hardware access, such as that typified by production-level optimization jobs, will become more widespread and when QC job usage demands an on-premises capability.

FIGURE 12

QC Hardware to Support Most Important QC-Based Optimization Effort

	All	Target	Secondary
Cloud access provided through a cloud service provider (CSP) to a quantum computing (QC) hardware supplier	39%	40%	38%
Direct cloud access provided by quantum computing (QC) hardware supplier	24%	25%	23%
On-premises quantum computing (QC) system	18%	17%	23%
Cloud access through a third-party quantum computing (QC) access curator	17%	18%	17%

N=303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

Figures 13 and 14 summarize survey respondents' selection when asked about the associated classical hardware provisioning that will be needed to support their most important QC-based optimization effort. By a slight margin (52%), the majority of respondents indicated that they would be relying on classical hardware, most often in the range of 64 to 256 nodes.

- The remaining 48% of respondents indicated that their organization would be relying on cloud instances to support their QC workloads, primarily with instances that would run less than one hour, but with a small portion of jobs (9%) using more than five to 24 hours instance per job.
- For the sum total of classical hardware access options, the most selected was 18% for on-premises servers 64 to 256 nodes, and 16% for cloud instances from one minute to 30 minutes per single job.

FIGURE 13

On-premise Classical Hardware Support for Most Important QC-Based Optimization Process by Node Count

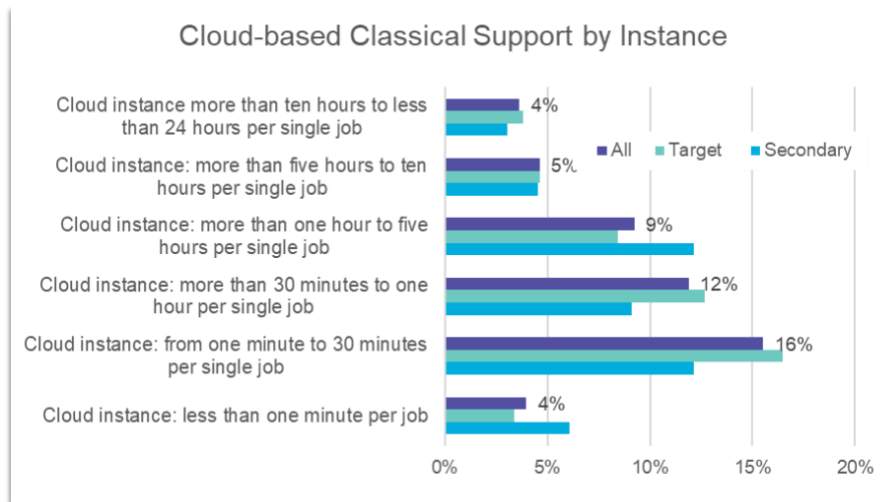On-Premises Classical Hardware Support by Node
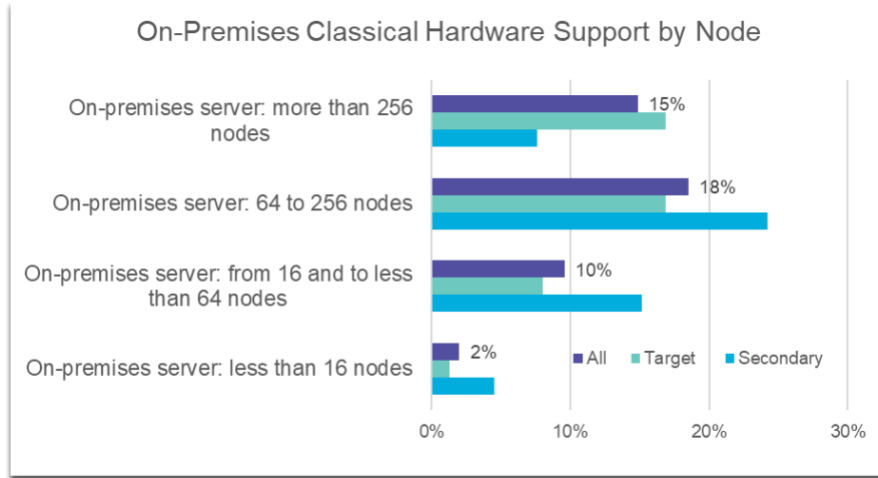
N=303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

FIGURE 14

Cloud-based Classical Hardware Support for Most Important QC-Based Optimization Process by Instance

Cloud-based Classical Support by Instance
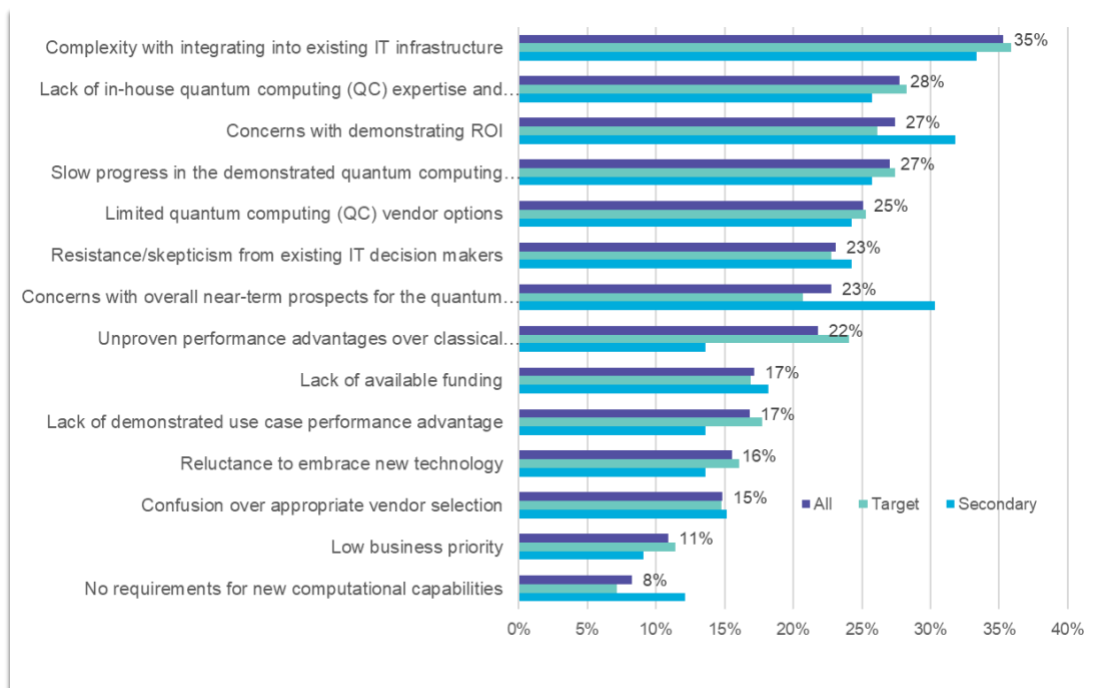
N=303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

Figure 15 summarizes survey responses on the greatest perceived hurdles to QC-based optimization. Leading responses were complexity with integrating into existing infrastructure (35%), lack of in-house QC expertise (28%), and concerns with demonstrating ROI (27%).

- There was an average of three hurdles identified by each respondent, and it is noteworthy that these hurdles include a swath of concerns spanning: corporate business dynamics, in-house and vendor technical expertise, QC performance capabilities, and QC market dynamics.
- The issue of survey respondents having new requirements for computational capabilities was identified by only a small percentage (8%) as a hurdle, which may signifying that there is significant pent-up demand for new compute that can address key computational workloads.

FIGURE 15

Greatest Hurdles to QC-Based Optimization

N=303, Target= 237, Secondary = 66

Note: Respondents could select all options that apply

Source: Hyperion Research, 2024

From the perspective of an organization's overall QC-based optimization activities, from which respondents were allowed to select all options that apply, organizations have varied plans to move forward within their overall QC-based optimization efforts as seen in Figure 16. The most selected option was to move forward with QC-related production activity, but at a measured pace, with modest increases in funding and internal resources commitment (62%), followed by maintain current level of effort for QC-related production activity funding and resources commitment for the next two to three

years (43%), and aggressively move forward incorporating quantum computing into the overall compute production environment (37%).

There were some cases where QC-based optimization efforts would be reduced (13%) or eliminated (6%), but it will require more study to determine if that outcome addresses a single effort within a company conducting multiple efforts, or the complete cessation of all QC-based optimization efforts within a company. Findings from other parts of this study strongly suggest it is the former.

FIGURE 16

QC-Based Optimization Efforts: Anticipated Commitment to All Activities
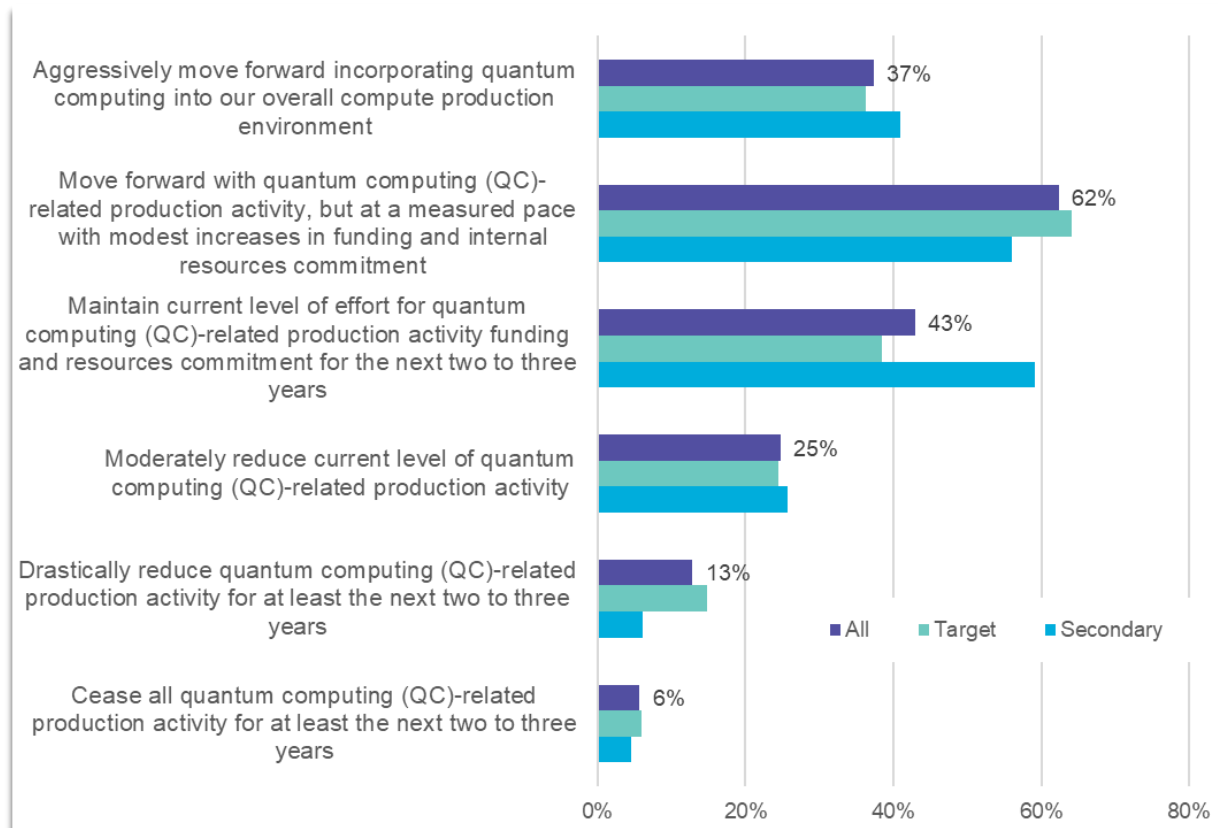
N=303, Target= 237, Secondary = 66. Respondents could select all options that apply

Source: Hyperion Research, 2024

QC-BASED OPTIMIZATION EFFORTS FROM A BUDGETARY PERSPECTIVE

This section covers some of the more important budgetary and financial aspects of respondent organizations' QC-based optimization efforts, including near-term budget commitment, long-term

budget expectations once QC-based optimization efforts reach a mature, stable production state, and related expectations for ROI.

Figure 17 summarizes respondents' selections for their organizations' overall budget for their entire range of ongoing QC-based optimization efforts in the next 12 months. The most selected option was for US$1 million to less than US$1.5 million, selected by about 1 in 5 of the respondents.

- One in five respondents expect to spend more than US$5 million in the next year, and one in nine more than US$7.5 million.
- For this question, the reported budget includes both expenditures that will go to the QC supplier baser as well as in-house expenditures to support a QC-based optimization program.

FIGURE 17

QC-Based Optimization Efforts Budget Over the Next 12 Months
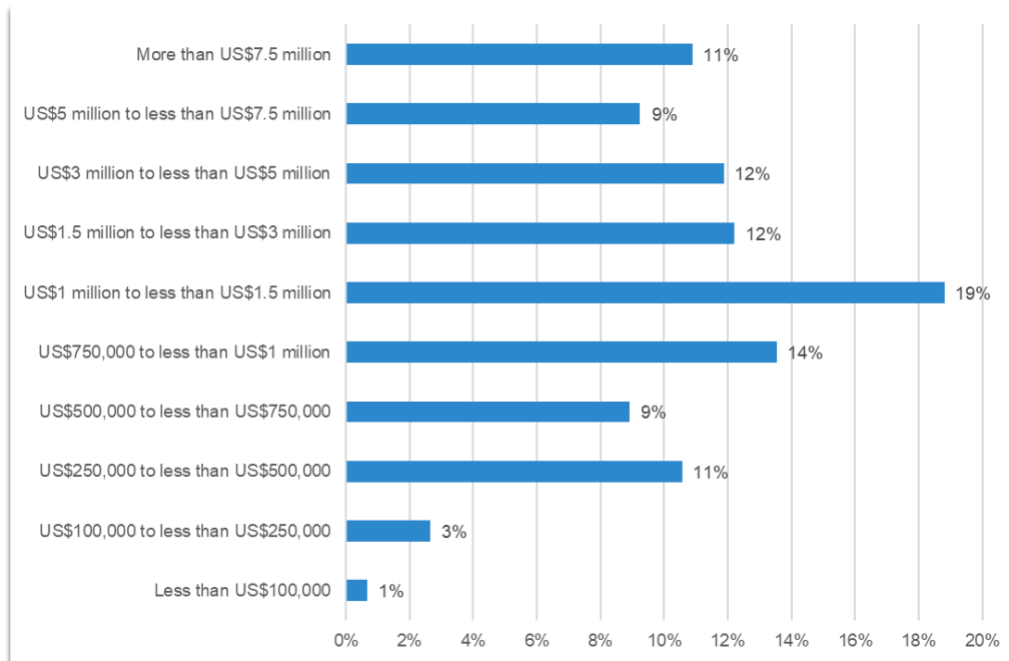
N = 303

Source: Hyperion Research, 2024

Figure 18 summarizes the selection from respondents when asked about their organization's long-term annual budget commitment once a fully capable QC-based optimization program is in place, a situation that could take a few more years. The most selected options were US$1,000,000 to less than US$5,000,000 (18%), US$5,000,000 to less than US$7,500,000 (14%), and US$500,000 to less than US$750,000 (12%).

- Ultimately about one third expected total budgetary commitments between US$1 million to US$7 million, and one quarter expect to commit over US$10 million annually.

- 15% of US respondent organizations expected to spend more than US$25 million per year.
- These budget numbers represent the total spending on QC-based optimization operations.

FIGURE 18

QC-Based Optimization Efforts: Long-term Annual Budgetary Commitments
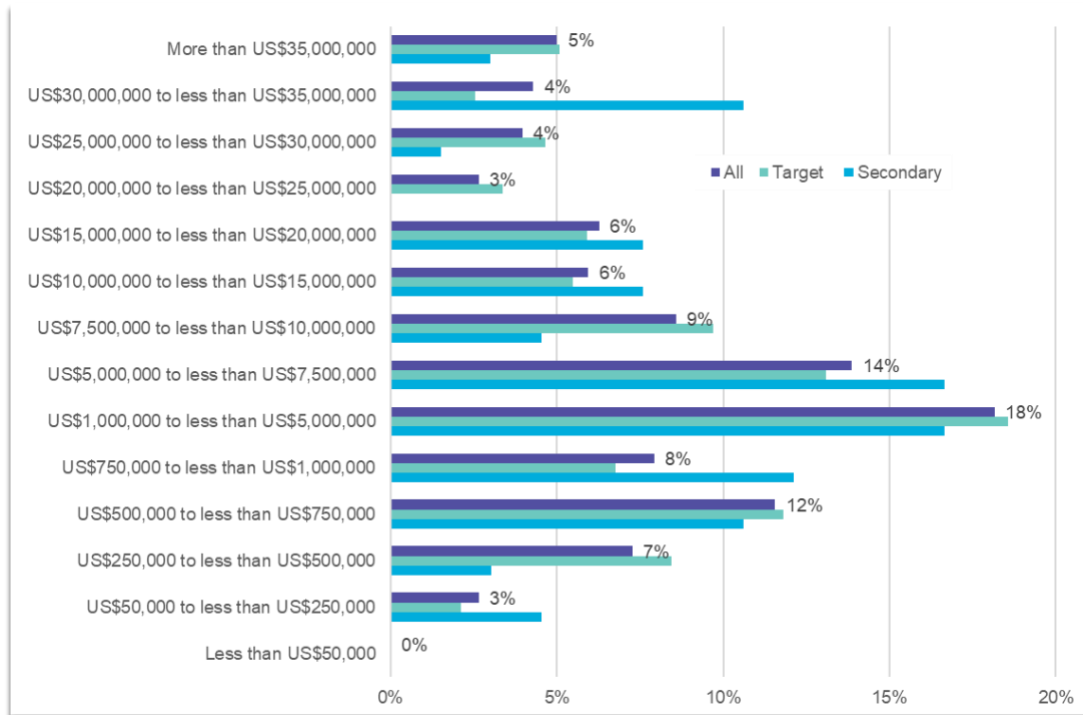

N=290, Target= 228, Secondary = 62

Source: Hyperion Research, 2024

Figure 19 summarizes survey respondents' selections for the long-term annual expected return on investment due to having a QC-based optimization operation. The three most selected options were US$25 million to less than US$100 million (20%), US$10 million to less than US$25 million (16%), and US$5 million to less than US$10 million (15%). Taken in total, this represents an estimated long-term total return on investment of US$51.5 billion for the 290 companies that responded to this question.

- One half expect between US$10 million and US$100 million in increased revenue from enacting QC-base optimization capability.
- About one third expect US$100 million or more.

FIGURE 19

QC-Based Optimization Efforts: Long-term Annual Expected Return on Investment (ROI)
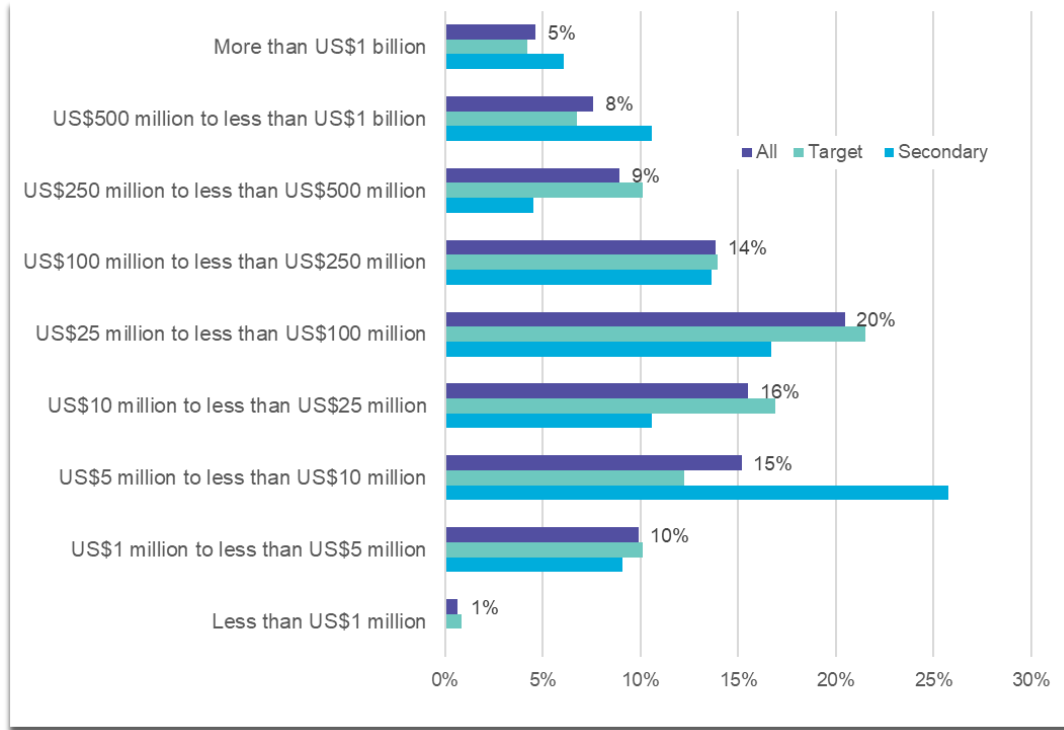

N=303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

Figure 20 correlates respondent organizations' long-term annual commitment to QC-based optimization operations with that organizations' expected ROI driven by a combination of factors such as greater operational efficiencies, increased revenue, increased competitive advantage and realizing cost saving. The most chosen options (the purple region near the center of Figure 19) highlight an area encompassing US$3-6 million expenditures with resulting revenues of US$60-65 million, representing an estimated ROI one of up to 20x.

- One out of ten respondents foresaw annual QC-based optimization budgets to exceed US$27 million while expecting an annual ROIs of US$376 million to over US$1 billion.

FIGURE 20

QC-Based Optimization: Long-term Expected ROI
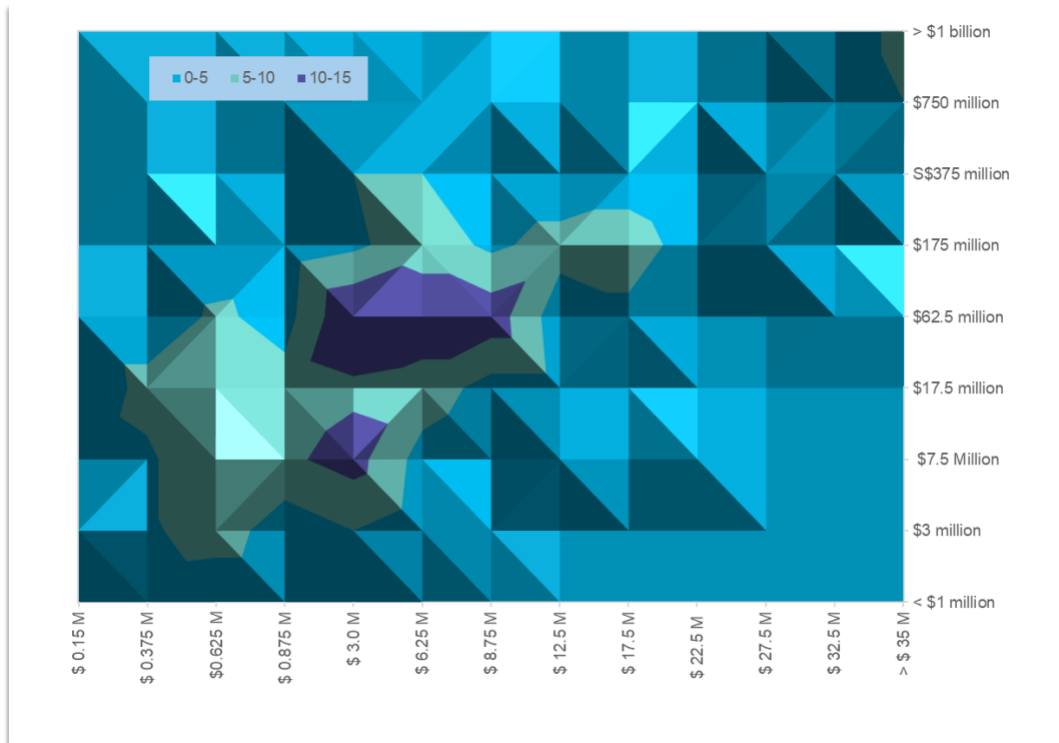
All values in US$ Millions, N=290

Source: Hyperion Research, 2024

Figure 21 presents respondents' outlook on the potential for QC technology to be combined with AI capabilities to open up additional compute opportunities, indicating that some organizations already have some pilot (39%) or even full production activities (29%) in place.

- It is left for future study to determine the specific types of AI under consideration, their envisioned value added when combined with QC-based optimization efforts, and what specific end uses will be most amenable to this hybrid capability.

FIGURE 21

QC and AI: Combining Forces on Optimization Efforts
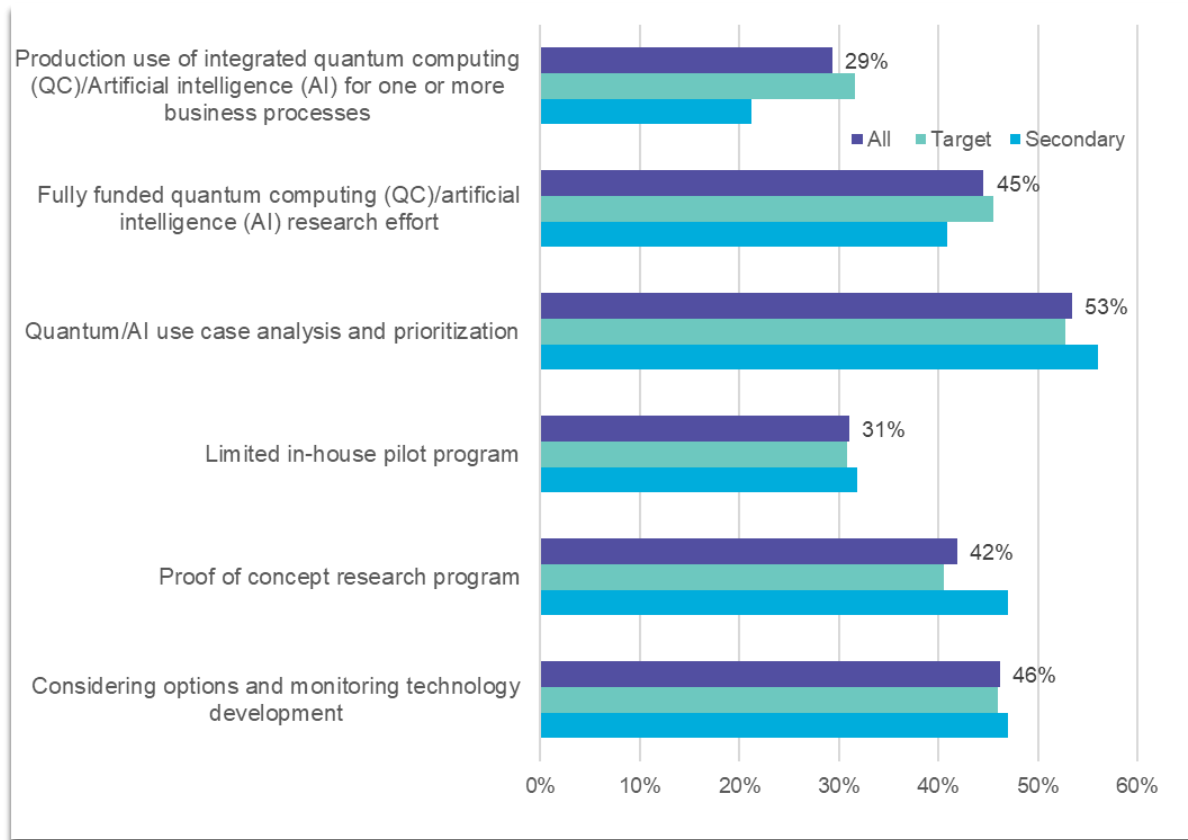
N=303, Target= 237, Secondary = 66

Source: Hyperion Research, 2024

SUMMARY

A wide base of commercial organizations are actively exploring the potential performance and financial advantages of integrating QC-based optimization into their overall computational environment. This study concentrated on the commercial and business potential of quantum computing, and indeed, ended up gathering data primarily from respondents of organizations that self-identify as a mixed enterprise/HPC environment, sites that many do not associate with the aggressive adoption of nascent and rapidly evolving emerging technologies, making the results all the more compelling.

Notably, this study highlights that the surveyed commercial organizations are largely optimistic that the capabilities of current and near-term quantum systems are capable of supporting critical business processes that can significantly increase their overall competitiveness. As such, these organizations are committing significant funds to explore opportunities and, based on their responses, appear likely to continue to refine their capabilities, ultimately moving a range QC-based optimization processes into their overall business operations.

These respondents' expectations are high for the financial benefits of such operations, and for its part, the overall quantum computing supplier base can only benefit from being able to offer improved capabilities for key commercial-oriented optimization processes.

- However, commercial end users will be carefully looking to that QC supplier base for better ways to address concerns such as complexities with integrating QC capabilities into classical ecosystems, from both a hardware and software perspective, navigating a lack of in-house end user expertise, unclear vendor selection criteria, and larger issues with the long-term viability of the sector.

- Vendors that can best mitigate these shortcomings appear to stand the best chance of achieving significant success in this rapidly growing and, perhaps more important, most promising near-term segment of the overall QC market.

APPENDIX: ADDITIONAL RESPONDENT ORGANIZATION DEMOGRAPHICS

This appendix contains additional details about the total revenue and IT budgets of the organizations participating in the survey as well as a summary of their current classical-based optimization software preferences.

Figures 23 and 24 present the surveyed organization total revenues and associated IT budgets estimates for 2024. The largest tranche of commercial organizations that participated in this study had estimated total revenues of between US$500 million and US$1 billion for 2024, although there was a wide range of organizations as measured by estimated total revenues for 2024 spanning from a low of US$15 million to more than US$10 billion. Likewise, estimated 2024 IT budgets were reported to in between US$10 million and US$25 million, but fully 85% had estimated 2024 IT budgets of between US$5 and US$50 million.

FIGURE 23

QC Optimization Developers' 2024 Estimated Total Revenues
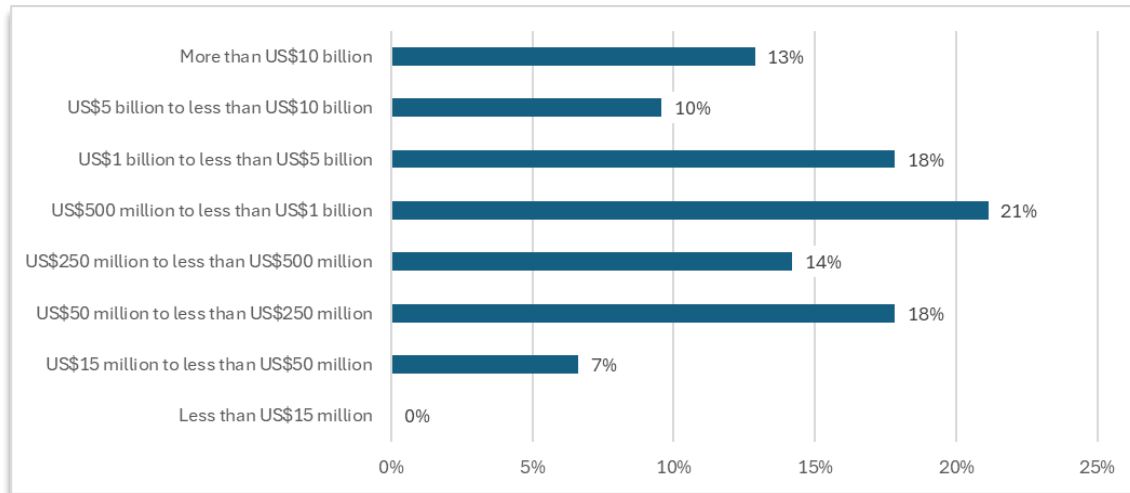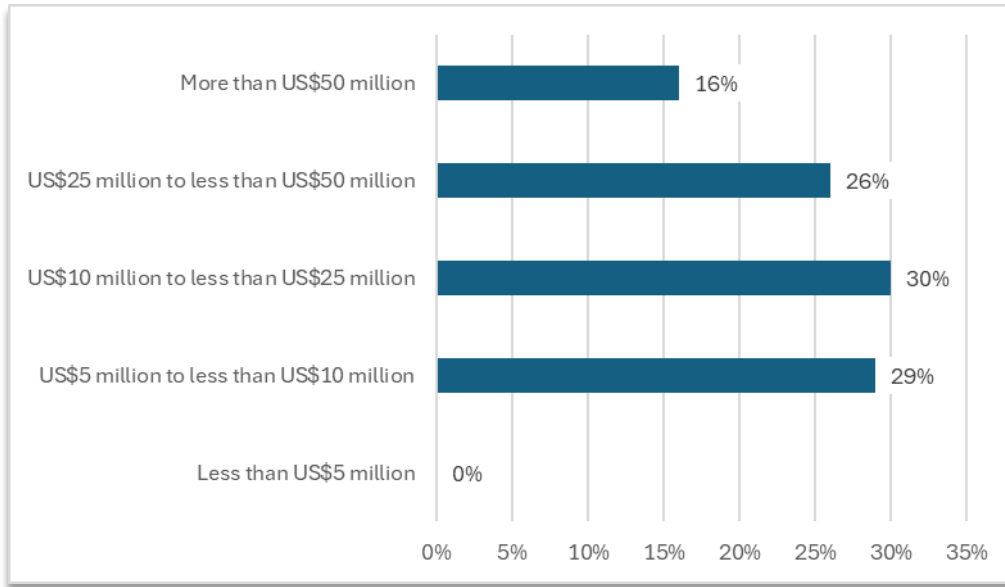

N=303

Source: Hyperion Research, 2024

FIGURE 24

QC Optimization Developers' 2024 Estimated IT Budgets

N=303

Source: Hyperion Research, 2024

Figure 25 sets out the current array of non-QC (classical) optimization software currently in use within the set of surveyed organizations. Google Cloud Datastore and SAP Data and Analytical Services were the most selected options (~60%), followed by AWS Data Pipeline (42%). There was an average of 2.4 choices per respondent, indicating that there are multiple classical optimization software packages in use within the base of surveyed organization.

- It remains to be seen if or when these classical optimization software packages are replaced by, or stand alongside, emerging QC-base optimization counterparts.

FIGURE 25

Current Non-QC (Classical) Optimization Software

	All	Target	Secondary
Google Cloud Datastore	59%	59%	58%
SAP Data and Analytics Services	59%	60%	55%
AWS Data Pipeline	42%	44%	32%
SAS/STAT	22%	25%	14%
Anaconda Distribution	14%	13%	17%
Power View / Power Pivot	13%	14%	11%
Alteryx Desktop	13%	12%	15%
CPLEX	10%	8%	18%
Simulink	6%	5%	8%
Gurobi	6%	5%	6%

N=303, Target= 237, Secondary = 66. Respondents could select all options that apply.

Source: Hyperion Research, 2024

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 and vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). Hyperion Research provides 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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