

From Business Problem to Quantum Proof of Value

A practical enterprise framework for use case discovery, fair experimentation and responsible readiness

Quantum computing is an emerging capability, not a general-purpose upgrade. For most organizations, the near-term task is to build disciplined readiness: identify a consequential computational bottleneck, test a clear hypothesis, compare against a credible classical approach and stop when evidence does not justify more investment. This paper presents a decision framework for that work and explains how the Quantum Use Case Studio can support early-stage discovery and planning.

APPLICATION

Quantum Use Case Studio

<https://quantum-use-case-studio.pages.dev/>

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Decision-support research. Verify technical, security, legal and supplier requirements before acting.

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Executive summary

Enterprise quantum programs create value first by improving the quality of decisions, not by assuming that a quantum processor will outperform today’s systems. Organizations need a repeatable way to screen ideas, expose assumptions, protect data, design fair tests and decide whether to continue.

- Begin with an important business decision and its best current method.
- Treat each quantum proposal as a falsifiable hypothesis with a named workload, metric and acceptance threshold.
- Keep classical, quantum-inspired and hybrid approaches in the comparison set.
- Separate technical fit, policy eligibility, economic value and organizational readiness.
- Fund learning in stages; a well-supported no-go decision is a successful outcome.

The practical question is not “Where can we use quantum?” It is “Which business bottleneck could justify a carefully bounded quantum experiment, and what evidence would change our decision?”

The OECD’s 2026 study of business readiness describes an exploratory, capability-building process and identifies technology maturity, unclear business use cases, cost and specialist talent as major barriers. The framework here responds by making discovery and evidence generation incremental rather than treating a technology demonstration as a business case [1].

1. The case for disciplined exploration

Quantum algorithms may offer advantages for particular structures of computational problems. That possibility does not imply that a useful speedup, lower total cost or better decision quality is available for a given enterprise workload today. Business value must include data preparation, encoding, orchestration, error mitigation or correction, classical post-processing, integration, governance and operating costs.

The 2026 OECD analysis characterizes quantum computing as early-stage and notes that many firms are exploring rather than deploying at scale. It recommends building readiness through awareness, skills, partnerships, infrastructure and small experiments [1]. That is a more defensible near-term objective than promising a general quantum advantage.

A useful portfolio therefore includes three kinds of work: (1) business-led use-case discovery, (2) technical evaluation of narrowly scoped workloads, and (3) organizational readiness such as skills, supplier diligence and governance. Each has distinct outcomes and should be tracked separately.

2. Start with a business bottleneck

A candidate should describe a business decision, not merely an algorithm. State who makes the decision, what is optimized or estimated, how often it occurs, what constraints are binding, what the current method does well and where it fails. Quantify the consequence of the gap using a metric leaders already value: cost, service, throughput, quality, risk or time.

Discovery question	Evidence to collect
Business objective	Decision owner, outcome, baseline KPI and consequence of improvement.
Computational bottleneck	Workload size, structure, constraints, run frequency and measured classical limits.
Current best method	Production solver or heuristic, tuning effort, hardware, runtime, solution quality and total cost.

Discovery question	Evidence to collect
Quantum hypothesis	Why the problem structure could suit a quantum or hybrid method; what must be true for value.
Data and policy	Classification, origin, permitted processing locations, transfer rules, retention and approvals.
Adoption path	Decision owner, engineering capacity, provider route, integration needs and plausible next step.

Selection should favor problems with a consequential bottleneck, a credible baseline, an available representative workload, a testable technical hypothesis and a sponsor willing to act on the result. High public visibility or algorithm novelty is not evidence of business fit.

3. Where to look and what to test

Optimization, simulation and sampling are useful search areas, not guarantees of quantum advantage. They should be treated as families of hypotheses whose relevance depends on a specific formulation, scale, data regime, quality target and classical comparator.

Candidate area	Business question	Example test and boundary
Optimization	Can a feasible plan improve a decision under many interacting constraints?	Compare routing, scheduling or allocation on the same instances and constraints as the incumbent solver. Include feasibility, solution quality, wall-clock time and operating cost.
Simulation and materials	Can a quantum or hybrid method estimate a scientifically relevant property at useful accuracy?	Choose a narrow molecular or materials question with a trusted reference method. Report error, system size, total resources and uncertainty; do not infer product value from a small demonstration.
Sampling and uncertainty	Can a candidate approach improve an estimate used in a risk or scenario decision?	Define the target distribution, error tolerance, confidence, sample budget and complete end-to-end cost. Compare with tuned Monte Carlo and other accepted estimators.
Hybrid workflows	Can quantum subroutines contribute within a workflow dominated by classical systems?	Measure orchestration overhead, data movement, queue delay, classical preprocessing and whether the quantum component changes the decision.

These examples are starting hypotheses only. The OECD identifies sectors such as pharmaceuticals, advanced materials, energy, finance and transportation as areas of potential commercial interest, while emphasizing that maturity and business relevance remain uncertain [1]. The Department of Energy’s quantum information science roadmap similarly frames scientific and engineering challenges as research priorities, not ready-made enterprise returns [2].

4. Design a fair proof of value

A proof of value should be designed before access to a favored processor or supplier shapes the question. Fix the workload, test set, constraints, quality threshold and budget. Record the strongest available classical method and permit it comparable tuning effort. Run repeated trials where stochasticity matters.

Measure	What a decision-quality comparison includes
Quality	Objective value or estimator error, feasibility, confidence intervals and domain-specific acceptability.

Measure	What a decision-quality comparison includes
Time	End-to-end elapsed time including compilation, queue, orchestration, retries and post-processing.
Cost	Access, usage, cloud infrastructure, specialist labor, data preparation, integration and repeat runs.
Scale and robustness	Performance as representative size and constraint density grow; sensitivity to input variation and device noise.
Operational fit	Data movement, deployment, security controls, service availability, skills and support obligations.
Reproducibility	Versioned code, algorithm and device identifiers, configuration, datasets, run records and independent review.

A result should be evaluated against a pre-agreed acceptance rule. A small instance that runs on a QPU can be an engineering milestone without demonstrating economic advantage. Report negative and inconclusive results. Benchmarking research emphasizes that application-level evaluations need context-sensitive metrics and cannot be reduced to a single hardware score [3].

5. Match routes only after constraints

A provider choice is a constrained procurement and architecture decision. Candidate routes may include customer-controlled classical or high-performance computing, quantum simulators, gate-based processors, annealers and managed multi-provider access layers. A route that fits technically can still be ineligible under data, geography, supplier, contractual or assurance requirements.

- Confirm the actual processing and support locations, including sub-processors and telemetry.
- Check workload support, SDK and version, access model, queue expectations, price basis and service terms.
- Review data retention, deletion, training use, incident handling, audit evidence and export paths.
- Confirm applicable assurance certifications and their scope; do not treat a provider logo as proof.
- Preserve a classical baseline and a route to stop or switch providers.

The Studio displays illustrative routes and makes uncertain provider evidence conditional. Its registry is not a live catalog, its fit signal is not a probability, and no route should be approved without current supplier validation.

6. A staged enterprise operating model

Stage	Work	Decision gate
Discover	Translate strategy and operations into a small number of costly or quality-sensitive computational decisions.	Named owner, baseline KPI and problem statement.
Qualify	Check problem structure, instance access, classical performance, skills, data policy and time horizon.	Testable hypothesis and an explicit reason quantum could be relevant.
Design	Specify dataset, comparator, metrics, threshold, budget, location, supplier controls and stop criteria.	Approved test protocol with an accountable sponsor.
Evaluate	Run a bounded experiment; capture full-system results and independent review.	Comparable evidence, limitations and reproducible artifacts.
Decide	Continue, redesign, monitor, partner or stop. Fund the next stage only if evidence supports it.	Recorded decision, owner, budget and trigger for reassessment.

A practical first 90 days can focus on a cross-functional discovery workshop, selection of one or two candidates, collection of baseline evidence, policy review and a written experiment protocol. This is a suggested planning pattern, not a universal delivery commitment. Organizations with safety-critical, regulated or classified workloads need their own assurance and approval processes.

7. Measure readiness without confusing it with advantage

Readiness measures whether the organization can ask and answer useful questions; they do not prove that quantum computing is superior. Useful indicators include percentage of candidate use cases with an accountable owner and measured baseline, availability of representative and permitted test data, staff capability, completion of supplier and policy reviews, reproducibility of experiments, and the proportion of experiments that meet predefined decision criteria.

Avoid vanity measures such as number of qubits tested, number of providers listed or number of proofs of concept completed without decision outcomes. Track avoided spend and time when a candidate is stopped early, as well as value delivered when a test passes.

8. What the Quantum Use Case Studio does today

The Quantum Use Case Studio is a browser-based, evidence-oriented planning prototype. It guides a user through use-case intake; applies transparent local heuristics; presents illustrative provider routes with eligibility explanations; records high-level data and geography guardrails; supports PoC/PoV planning, benchmark records and governance checklists; and offers a separate high-level PQC triage path.

The current Studio does not connect to an AI model, supplier API, simulator or quantum processor. It does not perform live provider verification, execute workloads, calculate validated business ROI or provide legal, security or certification decisions.

Projects are stored in local browser storage on the current device. The prototype has no login, tenant isolation, server-side database, encryption service or enterprise audit log. Users should not enter personal, regulated, confidential, classified or secret information. The application is a structured starting point for discovery, not a production platform.

The product vision may extend toward automated inventory, live provider data, policy integrations and workload execution. Those are future possibilities and are not represented as implemented capabilities in this paper.

Conclusion

Quantum readiness is a management discipline: choose consequential questions, measure the incumbent, protect information, test with comparable methods and invest in proportion to evidence. The best early quantum program is not the one that runs the most experiments; it is the one that learns quickly, makes transparent decisions and knows when to stop.

Explore the Quantum Use Case Studio: <https://quantum-use-case-studio.pages.dev/>

References

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