Methodology to Accelerate Federal Agency Adoption of Quantum Technologies

James Hornage[1,2(✉)]

[1] Capitol Technology University, Laurel, MD 20708, USA
jhornage@captechu.edu
[2] Springer Heidelberg, Tiergartenstr. 17, 69121 Heidelberg, Germany

Abstract. Current federal approaches to accelerating quantum adoption were designed prior to the broad implementation of modern technologies such as cloud computing and machine learning. The impact of increased expenditures in quantum computing research may be negated by slow adoption. A research-based approach that incorporates lessons learned from recent technology adoption challenges has the potential to dramatically improve quantum adoption rates.

Keywords: Quantum Adoption Framework · Enterprise Modernization · Accelerating Quantum Adoption · Quantum Governance

1 Introduction

Quantum computing is a critical future technology for the federal government. The National Quantum Initiative Act (H.R. 6227), signed on December 21, 2018, outlines a framework for supporting the research and development (R&D) of quantum technologies [1]. Research agencies such as Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation (NSF) have initiated a broad range of research activities [2] and programs [3] to develop an ecosystem of investment in critical enabling technologies. There has been a wide range of promising developments across the quantum field, both in academia and industry, and the rapid implementation of advances will be necessary to keep pace with other countries.

2 General Problem Statement

Accelerating quantum technology advance is as critical as ensuring its rapid adoption when capabilities mature. Significant research has been conducted and is ongoing to advance quantum technology, but there is a lack of research in the areas of quantum transition and adoption. Technology transition has historically been a challenging issue for the federal government. The government has had challenges adopting recent technologies such as cloud computing, and despite years of understanding the problem [4], there have not been any reports or studies that identify the type of model that can be applied across individual agencies and the whole of government to accelerate adoption.

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The complexity of quantum computing combined with its application across multiple domains (e.g. encryption and machine learning) will make it more difficult for individual agencies to implement.

Agency-level adoption of emerging technologies has traditionally lagged years behind commercial implementations. Prior research [5] to improve government adoption of agile principles historically is only conducted after years of stagnant government adoption. Digital transformation efforts around consolidating data centers [6], cloud computing, software defined networking, and zero trust architectures have also faltered at the agency implementation level. The potential impact of increased expenditures to accelerate the R&D of usable quantum technologies may be negated by the failure to implement effective approaches to accelerate implementation/adoption once technologies are ready for use.

3 Significance of Study

The ability of federal agencies to rapidly implement quantum technology has the potential for substantial cost savings, the ability to solve new problems, and the ability to maintain parity with other nations [7]. Despite congressional and government-wide attention to prior initiatives such as cloud computing, frameworks for government cloud implementation were developed only after widespread issues hindered adoption. The associated frameworks focus on documented issues, and they fail to address the actions that federal agencies can take in advance of widespread use. Quantum adoption within the federal government, both at large and within individual agencies, will benefit from a research-backed framework.

A framework for accelerating adoption that accounts for the breadth of potential quantum utility and the depth of agency and government-wide adoption challenges will enable faster realization of quantum technology gain. The framework is also likely to have applicability to large enterprises and other organizations. It will fill a critical research gap that exists as most ongoing research is focused on advancing quantum technology capabilities.

4 Comprehensive Study Approach

The purpose of the study is to develop a framework and associated set of implementation guidelines that can be used across government at large and individual agencies to accelerate adoption of quantum technologies. This requires analysis of prior and ongoing technology adoption efforts to identify methods that can be applied prior to mainstream technology use, application of the findings to specific quantum adoption challenges, and integration of all findings into a comprehensive method. This can be achieved through a three-phase process:

1. Use case analysis of cloud computing adoption.
2. Validation of best practice transferability and application to the federal quantum problem.
3. Integration of model elements into a synchronized methodology.

The figure below (Fig. 1) presents the conceptual framework.

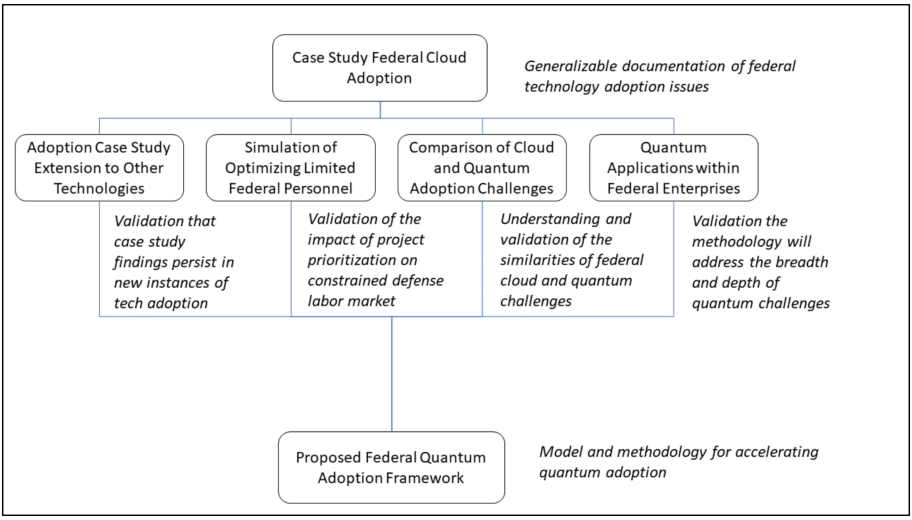

Fig. 1. Framework for Study to Develop Methodology and Model for Accelerating Quantum Adoption

The conceptual framework of the study involves a structured approach to developing a Federal Quantum Adoption Framework that is based on rigorous study of prior implementation challenges and then tailored to specific quantum challenges. The framework will be evaluated for generalizability against other ongoing technology adoption cycles. Modeling and simulation will be used to validate proposed optimizations, and anticipated quantum technology advancements will be evaluated to ensure the framework can scale to incorporate unexpected advances.

The study will use a collective case study model of research to understand delays, validate best practices, and identify methods that could have been pursued in technology adoption for virtualization, cloud computing, and other relevant transformation efforts. There will be a particular emphasis on what is required for implementation at the federal agency level.

The study also includes modeling and simulation to maximize the impact of the framework in addressing key labor shortages that exist in the federal environment, particularly for sensitive positions that require security clearances. Discrete event simulation will be leveraged to understand the impact of different implementations. Scenario forecasting will be used to understand and validate the effectiveness of the framework across a range of possible quantum adoption timelines. Where applicable, modeling and simulation will also be used to validate how the framework generalizes to other technologies and across non-federal quantum adoption.

5 Conclusion

There are recent technological advances that provide opportunities to research and understand the modern technology adoption challenges that are likely to impact quantum computing. The finding should be incorporated into a research-based Quantum Adoption Framework that can be tailored for the unique elements of governments and large enterprises. The proposed federal quantum adoption framework should be validated through use across multiple federal agencies.

Disclosure of Interests.. The authors have no competing interests to declare that are relevant to the content of this article.

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