# Challenges in Accelerating Technological Modernization in Government Agencies: Addressing Barriers to Updating Legacy Systems

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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**LEGACY SYSTEMS IN GOVERNMENT: AN IMPASSE OF MODERNIZATION**

Government agencies frequently rely on legacy systems—older technologies characterized by their age, lack of technical support, and replacement by more modern alternatives—to carry out critical operations. Agencies such as the Department of Defense, Department of Education, Health & Human Services, and Homeland Security continue to depend on these systems, which pose risks to national security and public well-being due to their heightened vulnerability to malicious attacks (Harris et al., 2019). One such example can be seen in the US Department of Veterans Affairs (VA). The VA relies on an outdated system for handling electronic health records - void of modern security measures - leaving it susceptible to cyber attacks (Laster, 2024). Maintaining these legacy systems is also an extremely costly endeavor, with expenditures reaching billions of dollars nationwide (Harris et al., 2019) - yet, a multitude of government agencies still rely on such legacy systems. Thus, it is of great importance to explore the different factors at play that are enforcing this phenomenon.

The factors demotivating modernizing in these aging systems are deeply rooted in social barriers and harmful governmental policy. Employee resistance to change, fear of losing control over familiar systems, and insecurity about new technology all contribute to reluctance in adopting updated solutions (Elgohary & Abdelazyz, 2020). Addressing these social and organizational challenges is essential for enabling the modernization of legacy systems and reducing the operational and security risks associated with outdated technology.

Certain government policy also significantly contributes to the lack of modernization efforts. Risk-averse legislative frameworks, bureaucratic inefficiencies, and rigid acquisition rules contribute largely to the lack of modernization efforts (*Roadmap for Renewing Our Federal*

*Government*). Examining and understanding these policy-based barriers is essential to begin formulating strategies to foster a more responsive government infrastructure.

This thesis examines the regulatory and social challenges of modernizing legacy government systems, focusing on the barriers that limit innovation in public agencies. It proposes solutions that address both the regulatory and organizational aspects of modernization. The thesis aims to bridge the gap between these dimensions by demonstrating how effective practices, grounded in existing STS frameworks, can foster a more collaborative and flexible approach to technology adoption. The central thesis of this research is that addressing socio-regulatory barriers is essential for modernizing government legacy systems and ensuring their security and efficiency.

## THEORETICAL FRAMEWORKS

Science and Technology in Society (STS) theory provides a comprehensive framework for analyzing the interconnected technical and social dimensions of legacy system modernization. This section applies two key STS concepts—path dependency and technological momentum—to frame the challenges and potential solutions for modernizing government legacy systems.

Path dependency explains how early technological choices create dependencies that are difficult to break, especially as systems become more deeply embedded over time (Mahoney, 2000). Initial investments in particular technologies often become "locked-in" due to the high cost—financial and operational—of transitioning to new systems. This "lock-in" effect contributes to the persistence of inefficient legacy technologies as industry standards, even when they no longer meet the needs of the organization (Barnes et al., 2004). Such a phenomenon

yields only hardship in the long-term, all for the sake of short-term convenience of not learning a new technology. Path dependency is reinforced by institutional policies and norms, which shape the technological trajectory of agencies. For instance, once a technology is established, agencies develop procedures and training programs around it, making future changes more costly and disruptive, accruing technical debt (Monaghan & Bass, 2020). Additionally, the financial implications of replacing or upgrading technology—including retraining staff and redesigning workflows—often deter agencies from pursuing modernization,creating a vicious cycle of stagnation.

Another STS concept that complements this perspective is technological momentum. Hughes (1987) posits that as a technology becomes integrated into social structures, it begins to shape society as much as society shapes it. In the case of government legacy systems, technological momentum implies that these systems do more than support organizational functions; they actively shape agency routines and employee roles. Over time, legacy systems acquire "inertia," making them increasingly difficult to overhaul or replace. This momentum reflects a paradox within government agencies: while technology is intended to foster efficiency, the degree of its integration within organizational practices can significantly slow modernization efforts. The more deeply entrenched a legacy system becomes, the more resistant it is to change—despite security and performance concerns (Schubert et al., 2013). This effect "snowballs" over time, such that older systems persist in any given agency far longer than appropriate, despite their clear limitations due to age. Moreover, the social reliance on these systems—as seen in deeply ingrained workflows and institutional knowledge—further complicates efforts to implement new technologies.

These frameworks highlight the need for a comprehensive approach to modernization that considers both technical and socio-cultural roadblocks. Path dependency and technological momentum suggest that efforts to modernize aging government systems must address the social elements at play, such as institutional resistance, rather than solely focusing on technical upgrades. By leveraging these STS concepts, this research aims to provide real, actionable insights into overcoming the complexities of modernization. This dual focus—on regulatory innovation and social adaptation—is essential to ensure the long-term success in modernizing legacy systems.

## CAUSE AND IMPACT OF LEGACY SYSTEMS

Legacy systems in government agencies represent a critical case study for examining the regulatory and social forces at play. These systems, which include infrastructure for national defense, healthcare, and public administration, are often maintained for decades despite their inefficiencies and vulnerabilities. The persistence of these systems is not solely a technical issue but reflects deeply rooted social and organizational dynamics.

Societal barriers to modernization often stem from institutional resistance, budgetary constraints, and regulatory policies that prioritize stability over innovation. Employees may resist modernization efforts due to fear of job loss, disruption to familiar workflows, or skepticism about the reliability of new technologies (Wellar et al., 2011). These barriers are further compounded by organizational inertia and risk-averse cultures that prioritize maintaining the status quo. It is worth noting that sometimes, these barriers are entirely unintentional - making them that much more tricky to identify and respond to. Addressing these challenges requires not only technical solutions but also strategies that foster a culture of adaptability and collaboration

within agencies. Understanding the interplay between societal and regulatory barriers is essential for developing effective modernization strategies. By addressing these factors in tandem, this research aims to contribute to the broader discourse on enhancing the efficiency and security of government systems.

## RESEARCH QUESTION AND METHODS

This research seeks to answer the following question: What are the primary socio-regulatory barriers to modernizing legacy systems within government agencies? To explore this, the study will employ two primary methodological components: Analysis of Existing Interviews with IT Professionals, and Government Policy Documentation Review.

Interview data will be used to identify patterns and trends in organizational resistance to modernization. Key indicators—such as employee attitudes toward change, organizational culture, and the perceived effectiveness of modernization initiatives—will be examined. Existing statistical findings, such as the correlation between resistance to change and reduced efficiency or poor performance (e.g., Elgohary & Abdelazyz, 2020), will be used to strengthen the analysis. These factors will be interpreted through two key STS frameworks: path dependency and technological momentum. These STS concepts will inform my research and analysis to provide a deeper understanding of the different factors at play.

Policies—financial, organizational, or otherwise—that influence IT practices within agencies will be reviewed to evaluate how they facilitate or hinder modernization efforts. Particular attention will be given to statutes that affect modernization strategies (directly or indirectly). For instance, fiscal policies allocating over $300 million annually to maintain legacy systems (Walsh, 2019) will be analyzed to understand their long-term implications. A few

notable policies that will be analyzed are the Federal Acquisition Regulation (FAR), Federal Information Security Management (FISMA), and Modernizing Government Technology (MGT). The goal is to pinpoint particular regulatory obstacles, and consider how agencies can move toward modernization without violating existing law.

By integrating these two methods of research, this work aims to provide a more holistic understanding of the interplay between social dynamics and regulatory constraints. Unlike existing literature that often isolates either the regulatory or the social dimension, this project seeks to explore their interaction to generate actionable insights and long-term, generalizable strategies for overcoming modernization barriers in government agencies.

## FINDINGS: INSTITUTIONAL HABITS AND POLICY FRICTION

The findings of this research demonstrate that both governmental policy and organization cultures create imposing barriers to the modernization of legacy systems in US federal agencies. Through analysis of an array of interviews with IT professionals, it became clear that risk aversion, institutional inertia, and "top-down" mandates drive modernization efforts, without considering the end users or rethinking outdated processes. Furthermore, the policy analysis shed light on how well-intentioned frameworks unintentionally reinforce stagnation by enforcing strict compliance and procedural burdens, discouraging any efforts toward innovation. These socio-regulatory obstacles together create a feedback loop, wherein technical updates end up replicating obsolete workflows and policy constraints prevent adaptive change, directly aligning with and being informed by the theoretical frameworks of path dependency, technological momentum, and reverse salience.

IT Professional Interviews and Survey Data

The findings of this research reveal that socio-regulatory barriers, organizational culture, and institutional inertia play a critical role in the modernization challenges faced by government agencies. While technical limitations of legacy systems are often blamed as the primary obstacle (which are indeed an obstacle), the data suggests that risk-averse policies, resistance to change, and an ever-entrenched reliance on dated workflows significantly hinder modernization efforts. After drawing from interviews with IT professionals and conducting policy document review, this work highlights that modernization is often approached as a purely technical upgrade, rather than an opportunity for organizational transformation. As a result, many modernization projects replicate outdated processes rather than innovating on them, lending itself to enter a cycle of inefficiency and technological stagnation. This aligns directly with the STS framework of path dependency, which argues that past decisions create constraints that eventually lock organizations into specific "paths" , even when better choices are available.

The findings from Alexandrova et al. (2015) directly support this conclusion by demonstrating how the legacy problem within government agencies extends beyond outdated technology to include institutional habits and procurement structures that tend to reinforce existing inefficiencies. Their work, based on interviews and survey data from practitioners across 30 different government organizations, found that legacy systems are being replaced in a very conservative manner, with newer systems being designed to simply replicate outdated business processes. Specifically, slightly over 42% of respondents admitted that "almost all" or "a lot" of the different features supported by the old systems were replicated in their newer counterparts, in the pursuit of minimizing operational disruption and maintaining user familiarity (Alexandrova et al., 2015, Table 8). Furthermore, roughly 62% of organizations settled on Commercial

Off-The-Shelf (COTS) solutions, which allow vendors to dictate feature selection as opposed to a more critical reassessment of important organization needs (Alexandrova et al., 2015, Table 6). These results - the replication of old processes within new systems - directly mirrors the idea of reverse salience. Even when a system is updated, key components lag behind in development, preventing the system from operating optimally in its new use-case. Furthermore, the preference for COTS solutions demonstrates the reluctance to assess internal needs and the habit of institutional risk aversion. Such a sentiment aligns directly with path dependency, the idea that past choices strongly influence the current state of a system. Agencies defer to vendor-provided solutions that adhere to the "norm" rather than exploring other appropriate technologies.

The interviews conducted in this study further bolster the impact of bureaucratic inertia. A common sentiment among the respondents was that decisions regarding modernization are often driven by executive leadership and institutional power structures rather than by an earnest evaluation of best practices. One respondent noted that "the mandate to integrate came from above" (Alexandrova et al., 2015). This common sentiment underscores the greater point that modernization projects are often "top-down initiatives" that do not engage the end-user in meaningful ways. Another factor at play is risk aversion - organizations seemed to exhibit a high degree of reluctance to deviate from the "norm" of existing workflows. That is, organizations typically choose to focus on technical compatibility and familiarity rather than strategic process improvement (Alexandrova et al., 2015).

## Policy Documentation Review

Legacy systems in governmental bodies provide an important case study for examining the policy barriers to modernization, and how they reinforce existing inefficiencies. Bureaucratic

inertia, outdated compliance requirements, and restrictive procurement laws significantly hinder efforts to upgrade government technology. As will be seen, this is again a manifestation of path dependency: policies that were initially made to promote security and fairness now effectively function as barriers that solidify outdated practices.

For instance, one of the leading documents that constrains modernization efforts is the FAR. The FAR imposes regulations that are designed to ensure transparency within agencies, but often lead to excessive delays in technology adoption. Agencies that attempt to modernize their systems must navigate lengthy compliance checks and contract-based obligations at every step, significantly slowing down the implementation of new systems. Specifically, the FAR enforces competition requirements (6 C.F.R, § 6.102, 2025) contractor qualifications (9 C.F.R, § 9.202, 2025) acquisition procedures (13 C.F.R, § 13.101-13.106), and quality assurance policies (46 C.F.R, §46.201-46.203, 46.501-46.505). One specific section (15 C.F.R § 101-2), named the LPTA (Lowest Price Technically Acceptable) policy states that agencies should prioritize price as the primary factor during acquisition. This directly leads to agencies selecting the cheapest vendor that meets minimum requirements: one specific example of the FAR hurting modernization efforts comes from the Professional Services Council (PSC). In the PSC, the LPTA was being misused for complicated IT services, leading to contracts that ultimately failed to reach modernization goals. As a result, agencies were left with systems that were barely technically sufficient, and poorly integrated (Benedetti, 2018) to lessen costs. These requirements were likely created in good faith to promote a healthy system of acquisition, but such policies are a double-edged sword - they prevent agencies from modernizing technology at a reasonable pace. These policies entail stagnation for agencies attempting to update or modify a system - another instance of reverse salience, in that the acquisition process itself becomes the

underdeveloped component that hurts the success of modernization initiatives. This sentiment is further bolstered by the fact that violating the FAR can, in some cases, result in severe fines and/or imprisonment (31 U.S.C § 2102).

Another significant document hindering modernization is FISMA. FISMA was created to define security standards and guidelines to protect government data, operations, and information. While this may seem wholly good on its face, there are a number of aspects of it that make modernization a herculean effort. The act, similarly to the FAR, imposes stringent compliance requirements that make it difficult for agencies to transition to new systems, since newer alternatives must meet extensive security assessments before deployment. Furthermore, FISMA centralizes oversight authority matters under DHS (Department of Homeland Security) and OMB (Office of Management and Budget), requiring agencies to adhere to ever-evolving directives that may delay modernization efforts. One provision states that agencies must "integrate information security management processes with budgetary planning" (Sen. Carper, 2014), directly restricting funding flexibility toward modernization. This act also mandates frequent risk assessments and security reporting, which divert resources away from technological advancements and often discourage agencies from adopting newer solutions due to fear of violating the policies in place. This is yet another example of how well-intentioned policies can unintentionally breed reverse salience. While FISMA does strengthen cybersecurity standards, its rigid structure leads to a sense of discouragement regarding modernization, and reinforces reliance on outdated systems.

The MGT Act, by contrast, is an attempt to address the path dependency problem by providing funding and resources toward the modernization of legacy systems "The bill establishes a Technology Modernization Fund for technology related activities, to improve

information technology, and to enhance cybersecurity across the federal government" (Rep. Hurd, 2017). This bill was made to combat the misallocation and budgetary constraints of IT funding, as according to a GAO report in 2019, the federal government allocates over 80% of IT budget on the maintenance of legacy systems (Walsh, 2019). Despite the statements presented in the MGT Act, little has been done to address the constraints imposed on governmental bodies by documents such as the FAR and FISMA.

A worthwhile note regarding these policies is that my work is not advocating for the complete abolition or repealment of the discussed legislation. Rather, a collaborative approach between policymakers and government agency authorities is a desired solution. Maintaining the core principles of the policies (increased cybersecurity efforts, funding efforts, etc) while introducing room for agencies to modernize systems at a reasonable pace is one potential way to ameliorate this issue.

## GENERALIZABILITY OF WORK AND FUTURE IMPROVEMENTS

This work links to broader theories in socio-tehcnical systems by demonstrating how institutional policy and regulations function as socio-technical barriers to modernization. It uses the frameworks of technological momentum, path dependency, and reverse salience to illustrate how policy decisions reinforce technological stagnation. These frameworks act complementary with one another, equipping me with an adequate foundation to conduct my analysis. Additionally, these frameworks tie into public administration tendencies that produce bureaucratic inertia, revealing why agencies struggle to adapt to current technology despite the clear enumerated benefits. Studies with similar motivations have documented how regulatory

frameworks can impact technological change in large industries  such as finance and healthcare, adding further context for the challenges faced by governmental bodies.

One limitation of this research is that it is centered on US federal agencies, which can limit the generalizability of the findings to other governmental structures. Secondly, this work uses qualitative analysis to further the proposed arguments. While qualitative analysis can offer detailed insights, it may lack the rigor of quantitative studies when discussing IT modernization. To improve on this, future research could include data-driven approaches to numerically measure the impact of policy reforms on modernization effort success, for example. Another potential area of improvement for future research is simply expanding the amount of interviews and government documents analyzed. Inspecting more interview data and documents would allow for a deeper, more robust conclusion.

If I were to conduct this research differently, I would widen the scope of the work to include multiple international case studies of modernization efforts in different governments. While at least one of my sources did incorporate international governmental bodies, perhaps collecting several more would have allowed for stronger evidence to be used.

This research will aid in advancing my engineering practice by enhancing my understanding of the impact policy can have regarding technological projects. As someone who will be working for a company directly subsidized by the government, understanding how social/organizational factors, in tandem with government policy, affect the technology in the workplace provides me with an invaluable insight to take with me into my career. Recognizing these institutional constraints will allow me to advocate for more effective modernization strategies, ensure compliance with regulations, and potential collaboration with policymakers to create solutions that benefit the company and align with legislative requirements simultaneously.

## PATHS FORWARD IN GOVERNMENT MODERNIZATION

This research highlights the pivotal role that societal barriers and government policy play in hindering the efforts toward the modernization of legacy systems. Employee resistance to change, risk-averse legislative frameworks, and bureaucratic inefficiencies foster harmful barriers that slow progress toward modernization and expose agencies with important duties to risk. Addressing these challenges requires a holistic approach that takes into consideration policy reform, cultural shifts that encourage adaptability, and increased funding flexibility.

The next steps for other researchers and policymakers primarily involve specific legislative changes that facilitate modernization, programs that invest in workforce training, incentivize innovation in government agencies, and promote change management strategies. The key takeaway from this work is that technological modernization in the government is not solely a technical problem, rather, it is deeply intertwined with societal barriers and policy decisions. By recognizing and addressing these barriers, government agencies can create a more resilient and adaptive IT infrastructure that will serve the public securely and efficiently.

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