An Actor-Network Theory Analysis of the Forbes Avenue Bridge Collapse and the Implications for U.S Infrastructure

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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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Introduction

United States infrastructure has consistently received subpar grades in the category of bridges since the adoption of the ASCE annual report card (Lo, 2014). A prime example of this unsatisfactory performance appears in the case of the Forbes Avenue Bridge collapse. In early January 2022, the Forbes Avenue Bridge over Fern Hollow Creek in Pittsburgh, Pennsylvania gave way, dropping passenger vehicles into the snowy ravine below. While there were no fatalities, ten people were seriously injured and required hospital treatment. Furthermore, just four months earlier, engineers had conducted an inspection in which they rated the bridge to be in poor condition (Gratzinger et al., 2022). The incident brings into question why the four-span structure and so many other infrastructure networks in the United States are failing, even with prior knowledge of their deficient structural nature. While current research acknowledges the deterioration of domestic infrastructure, scholars emphasize states and localities spending money on projects instead of placing responsibility on the federal government (Mcnichol, 2019). They also fail to address current time-consuming processes for obtaining approval of infrastructure funds and beginning rehabilitation maintenance and repairs. A flaw in the current understanding derives from responsibility being placed on state and local governments. In addition to smaller localities not having the capability to raise sufficient funds through taxes, this also reduces pressure on the federal government, resulting in sustained inaction. Without correctly identifying the key party accountable for the Forbes Avenue Bridge collapse, Fern Hollow citizens will remain incorrectly informed and bridges nationwide will continue to be structurally vulnerable. Similar cases to the bridge collapse will emerge across the country, putting the lives of every U.S citizen that relies on transportation infrastructure at risk.

In the case of the Forbes Avenue Bridge collapse, I will use actor-network theory (ANT) to argue that the federal government, rather than Fern Hollow citizens, engineers, contractors, or construction workers, was the primary actor responsible for the demise of the bridge network. Through defining key human and non-human actors that comprise the actor-network, I will lay out the structure of the overall system of the Forbes Avenue Bridge network. In the argument that follows, I utilize evidence from news reports, published report cards, and scholarly analyses. I will maintain that the Forbes Avenue Bridge technology failed due to a history of insufficient funding from the federal government causing an accumulation of infrastructure repairs as well as a timely procedure for maintenance and repair processes.

Background

In this section, I will briefly set forth the timeline and key facts of the case. Following the completion of the Forbes Avenue Bridge around 50 years ago, Fern Hollow citizens began traversing across the 450 ft structure for accessing work, school, or any other of their daily needs (Robertson and Kasakove, 2022). It remained in operation for the following fifty years without problem, only requiring routine maintenance. In September 2021, a thorough inspection of the bridge's deck and superstructure was completed, deeming the condition of the bridge as poor (Puksar and Scolforo, 2022). Following the inspection in the fall, the bridge remained in use for travelers with no serious repairs to the superstructure. On January 28, 2022, the Pittsburgh, Pennsylvania bridge collapsed, dropping a Port Authority bus and four passenger vehicles into the ravine below (Puksar and Scolforo, 2022). Later that same day, President Joe Biden had a meeting about the city's infrastructure and stated the urgency of his proposed $1 trillion bipartisan infrastructure plan that had passed just months earlier (Ichniowski, 2022). He visited the site of the crumbling bridge as he already planned to be in Pennsylvania to speak on the state

of its roads and bridges. While no life-threatening injuries were sustained, the case has prompted concern from many stakeholders regarding the current state of American infrastructure.

Literature Review

Several organizations have assessed the current state of domestic infrastructure and proposed various solutions. However, research on the Forbes Avenue Bridge collapse case individually and the factors that led to the ultimate failure of the technology is limited. While many of the analyses concur that U.S infrastructure is aging at a rate that current repair efforts can not sustain, they fail to consider the root cause of bridge repair inaction sufficiently.

In her work “In Flux: America’s transportation infrastructure,” Sharon Lo details the poor existing state of U.S bridge infrastructure, stating that although the American Society of Civil Engineers grade for bridge infrastructure has improved from a “C” to a “C+” since 2009, dilapidated bridges pose a “challenge for federal, state, and local governments to increase bridge investments by $8 billion annually.” She continues to emphasize the need for adequate transportation infrastructure through a quantitative analysis on metropolitan populations that rely on bridges for daily needs (Lo, 2014). However, Lo does not address the critical actors responsible for the stagnation in the repair process of domestic bridges. She also does not mention specific case studies of failing infrastructure in the United States.

Zeynep Dowd, Anna Franz, and James Wasek further dissect the matter of decaying domestic infrastructure through proposing a decision-making process that can optimize what infrastructure most-critically requires modernization or maintenance. They again agree that the main goal of the suggested algorithm is to offer a solution to “limited resources and growing backlogs" for infrastructure repairs (Dowd et al., 2020). While the authors do acknowledge an ever growing list of run down bridges and roads, they do not identify why the list is growing and

instead offer an analytical tool. Again, the analysis fails to address the crucial role that the U.S government plays in implementing repair processes domestically.

Similarly, Jason Baren adds to the discussion through bringing in the key player of the federal government. Using data from the Federal Highway Administration, he argues that infrastructure spending of tens of billions of dollars could be rationalized by the federal government (Baren, 2009). He goes as far to suggest a federally-chartered infrastructure bank. Baren's argument adds to previous literature in that it addresses the role that national spending plays in transportation infrastructure repairs. Nevertheless, Baren does not look at the specific case of the Forbes Avenue Bridge and the vital role the federal government played.

While existing literature accurately cites the presence of a problem with timely repair processes in United States infrastructure, they do not go in as far in depth as to diagnose a fundamental cause. They also fail to hone in on the specific case of the Forbes Avenue Bridge collapse. In this paper, I will examine the sociotechnical connection between relevant actors in the network of the Forbes Avenue Bridge technology. I will argue that the network failed due to a critical actor, the federal government, previously limiting funding towards domestic infrastructure and unsuccessfully enforcing the necessary steps towards maintaining the bridge in a timely manner.

Conceptual Framework

In analyzing the Forbes Avenue Bridge collapse, I will draw upon the science, technology, and society (STS) framework of actor-network theory which provides a holistic examination of the social and technical factors that influence a technology. ANT can be used to inspect how a network builder assembles a heterogeneous network, composed of human and non-human actors, to reach a goal (Cressman, 2009). The relationships between these

heterogeneous actors can be studied in how they influenced a particular failure or success. The advantage of examining both social and technical factors of a case include a greater probability of success for similar networks in the future. In defining the construction process in which the actor-network is formed and maintained, ANT utilizes Michel Callon's theory of translation (Callon, 1986). Callon separates translation into five subsequent processes: problematization, interessement, enrolment, mobilization, and black box.

In Callon's theory of translation, a primary actor, the network-builder, plays a key role in each of the stages in order to construct the actor-network. First, in problematization, the primary actor is responsible for identifying a novel problem and deciding the necessary actors that will be critical to achieving the solution. The identified actors must move through an "obligatory passage point" (OPP) in which their roles towards reaching the goal are defined. After moving through the OPP, the actors are rendered crucial in the stability of the overall network. Following problematization, interessement occurs where the primary actor then recruits the other necessary actors from competing networks to the new actor-network. When the other actors accept their defined roles in the network, translation enters the enrolment stage. The other actors begin to perform their assigned duties within the network. Mobilization takes place when the primary actor confirms their own role in the actor-network and begins to represent and mobilize the other actors toward the goal. The primary actor assumes a responsibility as a speaker for all other actors within the network. Finally, once all other phases of translation take place, the network develops into a "black-box", a stable system. A successful actor-network will continually operate as a black-box, evident to an external observer. Furthermore, the actor-network may be punctualized, in which the entire network becomes a node in another, broader network. If the primary actor does not successfully move the technology through the five stages of translation,

the network will ultimately operate in an unstable manner or fail as a whole. For this reason the primary actor carries a great amount of accountability in whether a network succeeds or fails.

In the analysis that follows, I begin by discussing the various roles of the actors composing the Forbes Avenue Bridge network including engineers, contractors and laborers, the federal government, Fern Hollow citizens, the Infrastructure Investment and Jobs Act, and the National Transportation Safety Board. I will then define a primary actor that is responsible for the instability of the Forbes Avenue Bridge network. Additionally, I will acknowledge the essential steps of translation that were waived by the primary actor which in turn, led to the failure of the technology. Finally, I will describe what this means for the future of U.S infrastructure if the network builder fails to change its current methodology.

Analysis

Within the Forbes Avenue Bridge actor-network, the federal government functions as the primary actor, bearing primary responsibility for the bridge disaster. The entity was defined as the most influential actor due to possessing the executive power to allocate funding for direct spending on transportation infrastructure construction and maintenance (Mallett, 2018). The federal government is responsible for overseeing the major steps of network formation in infrastructure projects and is therefore, chiefly responsible for the Forbes Avenue Bridge collapse. In my analysis, I will refer to several other stakeholders that both influence and are influenced by the bridge technology. These other heterogeneous actors are defined as shown: (i) *Fern hollow citizens* that use the bridge daily to access work, school, stores etc.; (ii) *bridge engineers* that developed the original design for the Forbes Avenue Bridge; (iii) *contractors and construction workers* responsible for providing the materials and labor for creating the bridge structure; (iv) *the National Transportation Safety Board* that is conducting a forensic

investigation and releasing official reports on the collapse; and (v) *the Infrastructure Investment and Jobs Act* that allocated $110 billion in new funds for transportation projects (*President Biden's Bipartisan…*, n.d).

In analyzing why the actor-network was ultimately unstable, I will look at existing evidence detailing the timely and inadequate funding that the federal government has allocated toward infrastructure projects. the network drawing associations between the various actors utilizing Callon's theory of translation. I will define the various actors in the context of the network formation as well as how the primary actor plays a larger role in the broader network of U.S infrastructure. I argue that the federal government played a crucial role in the failure of the Forbes Avenue Bridge Network due to previous inadequate funding for transportation infrastructure as well as timely processes for rehabilitation funding approval.

In the beginning stage of translation for the actor-network, the issue at hand was defined during problematization when the need for a bridge was identified. Around 50 years ago, the state government decided a structure was necessary to allow passage over Fern Hollow creek. With this decision, a federal government entity, the Federal Highway Administration (FHWA), allocated funding to the state government, which then identified how to move other actors through the OPP in order to create the structure (Kirk and Mallett, 2007). Following problematization, the government had to recruit various actors during interessement to perform specific roles in the creation of the bridge. The enrolment phase of translation followed, where the government hired the specific teams of engineers and contractors that agreed to perform their roles under employment contracts. Mobilization directly succeeded enrolment as the teams took action in reaching the goal. According to the Pennsylvania department of transportation, the

design and construction of the Forbes Avenue Bridge reached completion in 1970 (Gratzinger et al., 2022).

It is in the second to last stage of translation, mobilization, that I argue the federal government failed to adequately mobilize the necessary engineering and construction teams for the rehabilitation of the bridge. The two main inadequacies in mobilization were a lack of funding in years previous causing a backlog in infrastructure repairs as well as a timely procedure for maintenance and repair processes.

With thousands of decaying bridges nationwide, a lack of federal funding has left many structures in a deficient state. Due to a huge demand for federal resources, localities have historically struggled to afford repairs. In Philadelphia, Pennsylvania the accumulation of fiscal need for bridges rose to $300 million in 2013 (Semuels, 2013). Note that the city could not feasibly afford these repairs on their own so they directly relied on federal funding. Since the government did not allocate a sufficient amount to Pennsylvania, the need only continued to grow, representing a greater issue present across the United States. Deficits in infrastructure spending continued to grow while infrastructure continued to age.

Another prominent cause of the instability of the Forbes Avenue Bridge network was a timely process for rehabilitation that the federal government enforced. A classification of poor condition for a bridge in Pennsylvania correlates to a maintenance priority code of “4” (PennDOT, 2022). Although this classification indicated “advanced section loss, deterioration, spalling, or scour" in the Forbes Avenue Bridge, the protocol called for the Pennsylvania Department of Transportation to delay routine structural work until funds became available. Even though inspectors recognized issues with the structure, the sheer number of deteriorated

bridges and prolonged time for federal funding approval led to the collapse of the bridge before money could be allocated to the project.

Some theorists might argue that other actors such as the engineers in charge of the bridge design or the state government were primarily responsible for the demise of the structure. However, these arguments fail to consider that the design was structurally sound for the duration of its intended lifetime and that the state government was unable to act without funding approved by the federal government. Despite the September inspection, that necessary funding was not issued until after the bridge actually collapsed. The Pennsylvania department of transportation investigated FHWA emergency funding for the bridge following the collapse but instead decided to follow the existing procedure of waiting for approval of formula funding (Ichniowski, 2022). The $25.3 million allocated for the project was not approved by the federal government until February 1st, days after the cars were left stranded in Fern Hollow Creek.

The Forbes Avenue Bridge did operate as a black box, the final stage of translation, until January 2022. It was a stable network in itself that allowed for the transport of over 14,500 vehicles daily (Robertson and Kasakove, 2022). Most domestic bridges were designed to endure a lifetime of 50 years (American Society of…, 2017). As the bridge carried Fern Hollow citizens across the creek from 1970 to 2022, it operated as a stable network for the entirety of the planned lifetime. The instability in the network was due to federal regulatory error and not a failure of the design of the bridge.

In addition, the case of the Forbes Avenue Bridge network represents a larger issue in the broader actor-network of United States infrastructure. As the Forbes Avenue Bridge node is unstable for the aforementioned reasons, it can be logically concluded that the U.S transportation infrastructure network is inherently unstable. An actor-network made up of individually unstable

nodes will be vulnerable as a whole. While the current investigation by the National Transportation Safety Board could eventually reveal more intimate details of the collapse, the federal government is currently the primary actor in many smaller infrastructure networks across the country. The time-consuming and insufficient funding practices that the federal government imposed for the Forbes Avenue Bridge threaten multiple subnetworks within the U.S infrastructure network. Unless the current approach is altered, similarly disastrous events could occur at a greater rate across the country as the backlog for infrastructure repairs continues to grow.

However, not all hope is lost for American citizens as President Joe Biden's Infrastructure Investment and Jobs Act allocated over one trillion dollars toward U.S infrastructure with $110 billion going straight to supporting transportation projects (*President Biden's Bipartisan…*, n.d). Pennsylvania will directly receive $1.6 billion for their own 3300 bridges (Puksar and Scolforo, 2022). With more than 45,000 domestic bridges rated as structurally deficient, it is uncertain whether or not the Infrastructure Investment and Jobs Act will solve the issues that caused the collapse of the Forbes Avenue Bridge (Robertson and Kasakove, 2022).

Conclusion

Utilizing the STS framework of actor-network theory, I have defined the heterogeneous players that came together to form the Forbes Avenue Bridge network. In the analysis, the principal causes of the collapse were identified and a responsible party was pinpointed. In examining the various actors that comprise the Forbes Avenue Bridge network, it is apparent that the federal government was ultimately responsible for the collapse. The accountability of the government results from a long history of refusing to fund infrastructure maintenance that in

turn, caused an extensive backlog of needed repairs. Similarly, the government failed to enforce timely methods for maintenance and repair processes. Infrastructure projects across the country will continue to fail due to a lack of funding and unaddressed time-critical improvements. In understanding the claim, readers stand to gain an accurate depiction of the role of federal support in transportation infrastructure. They also will be able to identify the key party responsible for the demise of the Forbes Avenue Bridge.

While the comprehension of the argument is greatly beneficial to all U.S citizens, it is also especially vital for structural engineers. In designing massive transportation projects, it is essential to recognize the time-consuming and frugal practices of the federal government in maintenance and repairs. While the majority of the blame rests with executive authority in cases such as the Forbes Avenue Bridge, engineers need to realize that their designs can be pushed past their intended duration. Professional engineering practice should shift to designing for extended bridge lifetimes that include implementing fail-safe techniques to reduce the risk to everyday users.

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