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An Overton Window Index for Hazardous Material Governance: Modeling Policy Failure Trajectories in the Beirut (2020) and Shahid Rajaee (2024) Port Disasters

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Abstract

This study operationalizes the Overton Window concept into a quantitative framework for analyzing catastrophic industrial safety failures. Through a comparative case study of the Beirut port explosion (August 4, 2020) and the Shahid Rajaee port explosion (April 26, 2024), we demonstrate how the normalization of hazardous material storage practices shifts the boundaries of politically and socially acceptable risk. A novel Overton Window Index (OWI) is proposed to measure the temporal drift of risk acceptance in port governance systems. The analysis reveals that both disasters followed a five-stage trajectory: unthinkable risk, radical negligence, acceptable deviance, sensible inaction, and catastrophic normalization. The findings suggest that policy failure in hazardous material governance is not merely technical but deeply embedded in socio-political structures that progressively expand the window of tolerated risk until catastrophic failure becomes inevitable.

Keywords: Overton Window, Normalization of Deviance, Port Safety, Hazardous Material Governance, Catastrophic Failure, Policy Trajectory, Beirut Explosion, Shahid Rajaee Explosion

1. Introduction

On August 4, 2020, approximately 2,750 tons of ammonium nitrate stored at the Port of Beirut detonated, killing over 200 people, injuring more than 7,000, and leaving approximately 300,000 individuals homeless. The blast was equivalent to 1.1 kilotons of TNT, making it one of the largest non-nuclear explosions in recorded history. Less than four years later, on April 26, 2024, a similar catastrophe struck the Shahid Rajaee port in Bandar Abbas, Iran, when improperly stored sodium perchlorate and ammonium perchlorate ignited, resulting in 57 to 70 fatalities, over 1,000 injuries, and the destruction of at least 10,000 shipping containers across 15 hectares of port infrastructure. These two disasters, separated by geography, political systems, and economic structures, share a common structural pattern that demands rigorous theoretical and empirical investigation.

The progressive normalization of extreme risk within institutional frameworks responsible for hazardous material governance represents one of the most pressing yet under-theorized challenges in industrial safety research. Despite repeated warnings, documented regulatory violations, and observable unsafe practices, both the Port of Beirut and the Shahid Rajaee port operated under conditions that would have been deemed unthinkable in robust safety regimes. The ammonium nitrate in Beirut sat in Hangar 12 for seven years, adjacent to grain silos and densely populated residential neighborhoods, while port officials issued at least six formal requests for judicial guidance on disposal, all of which were ignored. In Bandar Abbas, oxidizing chemicals were stored in standard shipping containers at a facility reportedly affiliated with the Islamic Revolutionary Guard Corps, limiting civilian regulatory oversight and creating a zone of operational autonomy where standard safety protocols could be circumvented without consequence.

This phenomenon, whereby dangerous practices gradually become accepted through institutional inertia, political tolerance, and the absence of immediate negative feedback, has been described at the organizational level as the normalization of deviance. Diane

Vaughan developed this concept through her seminal analysis of the Challenger space shuttle disaster, demonstrating how technical deviations from safety standards become culturally normalized when repeated without catastrophic consequence. The absence of failure creates a feedback loop that validates increasingly deviant practices, rendering them invisible to the very institutions responsible for maintaining safety boundaries. However, normalization of deviance operates primarily at the micro-sociological level, explaining how organizations accommodate risk but not why political and regulatory systems permit such accommodation to persist over extended periods.

The Overton Window, originally conceptualized by Joseph Lehman at the Mackinac Center for Public Policy, provides a complementary macro-level framework for understanding how the boundaries of politically and socially acceptable policy options shift over time. The window moves through a spectrum from unthinkable to radical to acceptable to sensible to popular to policy, with ideas outside the window considered politically toxic and those inside capable of enactment without electoral or institutional penalty. While the Overton Window has been extensively applied in political science and public policy analysis, it has rarely been operationalized for empirical research and has never been systematically applied to industrial safety governance. This gap represents both a theoretical limitation and a practical opportunity.

The central problem addressed by this study is the absence of an integrated framework capable of capturing both the organizational dynamics of risk normalization and the political dynamics of risk tolerance. Existing safety science frameworks, including System-Theoretic Accident Model and Processes (STAMP), Functional Resonance Accident Model (FRAM), and bow-tie analysis, excel at modeling technical and systemic interactions but struggle to incorporate the socio-political dimensions of safety governance. These frameworks treat policy failure as epiphenomenal rather than constitutive, assuming that adequate technical systems will prevail if properly implemented. The Beirut and Shahid Rajaee cases demonstrate the inadequacy of this assumption. In both instances, technical knowledge of the hazard was abundant, regulatory frameworks existed on paper, and safety professionals recognized the danger. Yet catastrophe occurred not because of technical ignorance but because the socio-political window of acceptable risk had shifted to accommodate the very conditions that made catastrophe inevitable.

The limitations of existing frameworks become particularly evident when examining the temporal dimension of safety failure. STAMP, developed by Nancy Leveson, provides a powerful systems-theoretic approach to accident analysis by modeling the hierarchical control structures that should prevent unsafe behavior. However, STAMP assumes that control structures, once properly designed, will maintain their integrity over time. It does not adequately theorize the gradual erosion of control that occurs when political and economic pressures systematically undermine safety investments. Similarly, FRAM, developed by Erik Hollnagel, models the functional resonance that emerges from the variability of normal performance. While FRAM captures the dynamic complexity of socio-technical systems, it focuses on performance variability rather than the political decisions that define the boundaries of acceptable variability. Bow-tie analysis, widely used in process safety management, identifies barriers between hazards and consequences but treats these barriers as static configurations rather than politically contingent arrangements subject to renegotiation.

The need for a framework that integrates socio-political dynamics with organizational safety processes becomes urgent when considering the global pattern of catastrophic industrial accidents. From the Bhopal disaster in 1984 to the Deepwater Horizon explosion in 2010, from the Tianjin port explosions in 2015 to the Beirut and Shahid Rajaee catastrophes, a recurring pattern emerges: technical hazards are identified, warnings are issued, regulatory frameworks exist, yet catastrophic failure occurs because the political will to enforce safety standards erodes over time. This erosion is not random but follows a predictable trajectory that existing safety science frameworks cannot adequately capture. The Overton Window, precisely because it theorizes the political boundaries of acceptable policy, offers a missing dimension that can complement and extend existing technical and organizational frameworks.

This observation gives rise to the primary research question guiding this investigation: How can the Overton Window be operationalized as an analytical tool for understanding catastrophic policy failure in hazardous material governance, and what does this framework reveal about the structural similarities between the Beirut (2020) and Shahid Rajaee (2024) port disasters? Three subsidiary questions follow from this primary inquiry. First, what are the identifiable stages through which the Overton Window shifts in port safety governance, and how do these stages map onto documented events in the Beirut and Shahid Rajaee cases? Second, how does the normalization of deviance at the organizational level interact with the shifting Overton Window at the political level to produce catastrophic failure? Third, what measurable indicators can be derived from the Overton Window framework to construct an index capable of predicting or diagnosing the trajectory of risk acceptance in hazardous material governance systems? The theoretical contribution of this study lies in the integration of two previously disconnected frameworks: the Overton Window from political science and the normalization of deviance from sociology of organizations. By demonstrating that these frameworks operate at complementary levels of analysis and interact to produce catastrophic outcomes, the study advances a socio-political theory of industrial safety failure that moves beyond technical and organizational explanations to incorporate the political economy of risk tolerance. The practical contribution lies in the operationalization of the Overton Window through a proposed Overton Window Index (OWI), which provides a measurable diagnostic tool for assessing the trajectory of risk acceptance in port governance and potentially other hazardous material management contexts.

The study employs a comparative case study methodology, analyzing the Beirut and Shahid Rajaee explosions as instances of a common structural pattern. Case study methodology is particularly appropriate for this investigation because the research questions are explanatory rather than predictive, the phenomena under investigation are contemporary events over which the investigator has no control, and the boundaries between the phenomenon and context are not clearly evident. The cases were selected using a literal replication logic, where similar results are predicted for theoretically predictable reasons. Both cases involve catastrophic explosions of improperly stored hazardous materials in major commercial ports, both occurred in contexts of documented regulatory failure, and both resulted in significant loss of life and infrastructure damage.

Data for the analysis were drawn from multiple sources including official government statements, international organization reports, investigative journalism, satellite imagery analysis, and academic studies. For the Beirut case, the evidentiary base is extensive, including judicial investigations, parliamentary inquiries, and international forensic analyses. For the Shahid Rajaee case, data availability is more limited due to restricted information flows from Iranian authorities, but sufficient documentation exists from maritime safety organizations, supply chain risk analysts, and international media to reconstruct the basic trajectory of events. The analysis triangulates across these sources to establish reliability and validity. The remainder of this article is organized as follows. Section 2 presents the theoretical framework, integrating the Overton Window and normalization of deviance and proposing the Overton Window Index. Section 3 details the methodology. Sections 4 and 5 present the case analyses of Beirut and Shahid Rajaee respectively. Section 6 offers a comparative analysis of the two cases. Section 7 discusses theoretical and practical implications, acknowledges limitations, and concludes with directions for future research.

2. Theoretical Framework

2.1. The Overton Window and Policy Change

The Overton Window describes the spectrum of ideas that the public and political actors find acceptable at a given moment. The window moves through six stages: unthinkable, radical, acceptable, sensible, popular, and policy. Ideas outside the window are politically toxic; those inside can be enacted without electoral penalty. In the context of industrial safety, the Overton Window can be reconceptualized as the range of risk levels that institutions, regulators, and operators consider tolerable. When safety violations occur without immediate consequence, the window shifts to accommodate greater risk. This shift is not random but follows predictable patterns driven by economic pressure, regulatory capture, institutional inertia, and political prioritization.

2.2. Normalization of Deviance

Vaughan defined normalization of deviance as the gradual process through which unacceptable practice or standards become acceptable. In her analysis of the Challenger disaster, she demonstrated how NASA engineers and managers progressively redefined acceptable risk parameters following successful launches that violated safety protocols. The absence of catastrophic failure created a feedback loop that validated increasingly deviant practices. The normalization of deviance and the Overton Window operate at different but complementary levels. Normalization of deviance describes the micro-level cultural processes through which individuals and organizations accommodate risk. The Overton Window describes the macro-level political environment that permits such accommodation. Together, they explain how catastrophic failures emerge from the intersection of organizational culture and political tolerance.

2.3. The Overton Window Index (OWI)

To operationalize the Overton Window for empirical analysis of safety governance, we propose the Overton Window Index (OWI): OWI_t equals S_t plus P_t divided by U_t plus R_t plus A_t plus S_t plus P_t, multiplied by 100. Where U_t represents frequency of formal objections to safety regulations, R_t represents volume of safety proposals in specialized media, A_t represents number of safety regulations under review, S_t represents implementation rate of existing safety standards as percentage, and P_t represents number of enacted safety laws. The OWI ranges from 0, indicating complete closure where safety is unthinkable, to 100, indicating full normalization where safety is institutionalized. The velocity of window shift is calculated as the derivative of OWI with respect to time, equal to OWI at t plus 1 minus OWI at t, divided by delta t. Negative velocity indicates window closure toward risk acceptance; positive velocity indicates expansion toward safety institutionalization.

3. Methodology

This study employs a comparative case study methodology to analyze the Beirut (2020) and Shahid Rajaee (2024) port explosions through the integrated framework of the Overton Window and normalization of deviance. Data sources include official government statements, international organization reports, investigative journalism, and satellite imagery analysis. The analytical procedure involves chronological reconstruction of safety governance in each port, identification of documented safety violations and regulatory interventions, classification of each period according to the five-stage Overton Window framework, and comparative analysis of policy failure trajectories.

4. Case Analysis: The Port of Beirut (2013-2020)

4.1. Stage 1: Unthinkable Risk (2013-2014)

In November 2013, the Moldovan-flagged vessel Rhosus arrived at the Port of Beirut carrying 2,750 tons of ammonium nitrate. The cargo was impounded due to technical deficiencies and the owner's financial disputes. At this stage, storing such quantities of ammonium nitrate in a densely populated urban port was, technically speaking, unthinkable under standard maritime safety protocols. The Lebanese Customs Directorate and Port Authority possessed legal authority to dispose of the material or relocate it.

4.2. Stage 2: Radical Negligence (2014-2015)

Between 2014 and 2015, port officials issued at least six letters

to Lebanese judges requesting guidance on the disposal of the ammonium nitrate. No judicial action was taken. The material remained in Hangar 12, adjacent to grain silos and residential areas. This period represents the transition from unthinkable to radical, where the risk was recognized by technical experts but dismissed by political authorities as administratively inconvenient.

4.3. Stage 3: Acceptable Deviance (2015-2017)

By 2015, the presence of ammonium nitrate had become an established fact of port operations. Security personnel reported that Hangar 12's doors were improperly secured, and the material was exposed to environmental conditions. In 2016, port officials proposed selling the ammonium nitrate to the Lebanese Armed Forces or exporting it; both proposals were ignored. The risk had now entered the acceptable range, technically a violation but politically tolerable because no catastrophic event had occurred to invalidate the complacency.

4.4. Stage 4: Sensible Inaction (2017-2019)

Between 2017 and 2019, multiple warnings were issued. A 2016 report by a team of experts recommended immediate removal of the material; the report was ignored. In 2019, a chemical expert warned that the ammonium nitrate could blow up all of Beirut if not removed. The warning was not acted upon. At this stage, inaction had become the sensible policy. Any proactive safety measure would have required political capital, financial resources, and institutional coordination that competing priorities made seem unreasonable.

4.5. Stage 5: Catastrophic Normalization (2020)

By 2020, the presence of 2,750 tons of ammonium nitrate in Hangar 12 had been normalized to the point of invisibility. On August 4, 2020, a fire initiated in an adjacent warehouse containing fireworks and flammable materials spread to the ammonium nitrate, triggering one of the largest non-nuclear explosions in history. The catastrophe was not an aberration but the logical culmination of a seven-year trajectory of risk normalization.

5. Case Analysis: The Shahid Rajaee Port (2020-2024)

5.1. Stage 1: Unthinkable Risk (2020-2022)

The Shahid Rajaee port, Iran's largest commercial port handling approximately 80 million tons of cargo annually, operated under strict security protocols due to its strategic importance and proximity to sensitive military installations. The storage of oxidizing chemicals such as sodium perchlorate and ammonium perchlorate in standard shipping containers within the port's container yard was, under standard international safety regulations, unthinkable. These materials require specialized storage facilities with temperature control, fire suppression systems, and isolation from combustible materials.

5.2. Stage 2: Radical Negligence (2022-2023)

By 2022, reports indicate that chemicals were being stored in standard containers at the Sina Marine Services facility within the port complex. The facility was reportedly affiliated with the Islamic Revolutionary Guard Corps, which may have limited civilian regulatory oversight. Port safety inspectors, if they identified violations, lacked authority to enforce compliance against military-affiliated entities. The risk had transitioned from unthinkable to radical, recognized by technical personnel but politically insulated from corrective action.

5.3. Stage 3: Acceptable Deviance (2023-Early 2024)

By late 2023, the storage of hazardous chemicals in standard containers had become an operational norm. The absence of fires or chemical incidents during this period validated the practice. Workers and managers developed informal protocols for handling the materials that deviated from international standards but were functionally adequate for daily operations. The deviation had been normalized. The absence of catastrophe was interpreted as evidence of safety rather than as temporary avoidance of failure.

5.4. Stage 4: Sensible Inaction (Early 2024)

In the months preceding the explosion, no significant regulatory intervention occurred. The port continued to process approximately 80 million tons of cargo annually. The economic and political costs of halting operations to relocate or properly store the chemicals outweighed the perceived risk of maintaining the status quo. Inaction was the sensible policy within the institutional logic of the port's operations.

5.5. Stage 5: Catastrophic Normalization (April 26, 2024)

On April 26, 2024, a fire initiated in the chemical storage area. The exact ignition source remains under investigation, but the presence of oxidizing chemicals in improperly configured containers ensured rapid fire spread and eventual explosion. The explosion killed 57 to 70 people, injured over 1,000, destroyed 10,000 containers, and devastated 15 hectares of port infrastructure. As with Beirut, the catastrophe was not an unpredictable accident but the inevitable outcome of a normalized trajectory of risk acceptance.

6. Comparative Analysis

6.1. Structural Similarities

Both disasters exhibit striking structural similarities that transcend their different political and economic contexts. The hazardous material in Beirut was ammonium nitrate at 2,750 tons, while in Shahid Rajaee it was sodium and ammonium perchlorate in quantities not fully disclosed. The storage violation in Beirut involved improper warehouse storage, while in Shahid Rajaee it involved standard container storage. The duration of risk was seven years in Beirut and two to four years in Shahid Rajaee. Regulatory warnings were multiple and ignored in Beirut, and likely present but authority-limited in Shahid Rajaee. The institutional barrier in Beirut was judicial inaction, while in Shahid Rajaee it was military-affiliated entity autonomy. Economic pressure in both cases favored maintaining operations over safety investment. Fatalities were over 200 in Beirut and 57 to 70 in Shahid Rajaee. Injuries exceeded 7,000 in Beirut and 1,000 in Shahid Rajaee. Structural damage left 300,000 homeless in Beirut and destroyed 15 hectares in Shahid Rajaee.

6.2. The Overton Window Trajectory

Both cases follow a similar five-stage Overton Window trajectory. First, unthinkable to radical, where technical experts recognize risk but political authorities defer action. Second, radical to acceptable, where repeated non-catastrophic operation validates complacency. Third, acceptable to sensible, where corrective action becomes administratively unreasonable. Fourth, sensible to popular, where inaction becomes the default institutional response. Fifth, popular to catastrophic, where normalized risk materializes as catastrophic failure. The velocity of window shift appears to correlate with institutional opacity. In Beirut, judicial inaction slowed the trajectory over seven years. In Shahid Rajaee, military-affiliated operational autonomy may have accelerated the trajectory to four years or less.

6.3. The Normalization Mechanism

Vaughan's normalization of deviance operates as the micro-level mechanism driving the macro-level Overton Window shift. In both ports, technical deviation was repeatedly successful as no catastrophe occurred. Success was interpreted as proof of safety rather than as temporary avoidance. Cultural redefinition occurred where safe enough replaced compliant with standards. Institutional memory of proper procedures atrophied as deviation persisted. This mechanism explains why catastrophic failure occurs not despite safety systems but because of their gradual erosion through normalized deviation.

7. Discussion

7.1. Theoretical Implications

This study demonstrates that the Overton Window, when operationalized through the OWI framework, provides a valuable macro-level complement to Vaughan's micro-level normalization of deviance. While Vaughan explains how organizations accommodate risk, the Overton Window explains why political and regulatory systems permit such accommodation. The integration of these frameworks offers a comprehensive model for understanding catastrophic policy failure in hazardous material governance.

7.2. Practical Implications

The OWI framework suggests several practical interventions. Early warning systems monitoring the velocity of window shift can identify ports or facilities approaching catastrophic normalization before failure occurs. Regulatory design should include window hardening mechanisms, regulatory requirements that cannot be overridden by local political or economic pressures. Institutional independence is critical, as both cases highlight the dangers of regulatory capture. Safety oversight must be structurally independent from operational and political authorities. International standards are essential because the global nature of shipping and port operations demands international enforcement mechanisms that transcend national political windows

7.3. Limitations

This study is limited by data availability. The Shahid Rajaee case lacks the extensive documentary record available for Beirut due to restricted information flows from Iranian authorities. The OWI framework, while theoretically grounded, requires further empirical validation across additional cases to establish generalizability.

8. Conclusion

The Beirut (2020) and Shahid Rajaee (2024) port explosions were not isolated accidents but manifestations of a systemic pattern in hazardous material governance: the progressive normalization of extreme risk through the intersection of organizational deviance and political tolerance. By operationalizing the Overton Window through the proposed OWI framework and integrating it with Vaughan's normalization of deviance, this study provides a theoretical and analytical foundation for understanding and potentially preventing similar catastrophes. The central finding is sobering. Catastrophic industrial failures often occur not because safety systems fail to detect risk, but because the socio-political window of acceptable risk has shifted to accommodate the very practices that make catastrophe inevitable. Reversing this trajectory requires not merely technical compliance but the political will to maintain safety standards outside the mutable boundaries of institutional convenience.

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