**A Qualitative Systematic Review on the Application of the Normalisation of Deviance
Phenomenon Within High-Risk Industries**

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Abstract

The concept of normalisation of deviance describes the gradual acceptance of deviant observations and practices. It was first coined in the 1990's following a detailed examination of the Challenger space shuttle disaster. The phenomenon is founded upon the gradual desensitisation to risk experienced by individuals or groups who recurrently deviate from standard operating procedure without encountering negative consequences. Since its inception, normalisation of deviance has seen extensive, but segmented, application across numerous high-risk industrial contexts. Application and research of the phenomenon across these contexts has not yet been synthesised, resulting in a gap within the present literature that limits our understanding of its theoretical application. Consequently, the current paper describes a systematic review of the existing literature on the topic of normalisation of deviance within high-risk industrial settings. The aim of the review was to obtain an understanding of the concept's application and evolution, synthesise common findings, and identify the nature and limitations of current methodology. The review process identified 34 papers that met all inclusion criteria. Based on the review an initial conceptual framework was developed to encapsulate identified themes and their interactions; key themes linked to normalisation of deviance included risk normalisation, production pressure, culture, and a lack of negative consequences. While preliminary, the present framework offers relevant insights into the phenomenon that may help guide future analysis using primary data sources and aid in the development of intervention methods.

Keywords: normalisation of deviance, risk normalisation, systematic review, high-risk industry, safety

1 Introduction

In January of 1986, after only 73 seconds of flight, Space Shuttle Challenger broke apart above the Atlantic Ocean. Following the incident, a Presidential Commission was established with the aim of uncovering the contributory factors and causes of the disaster. On a technical level, the vehicle's disintegration stemmed from the failure of eroded O-ring seals. This failure enabled the leakage of hot gas from the right booster rocket, culminating in structural collapse (NASA, 1986). Given the distinct and apparently avoidable nature of the failure, the question of why the issue had not been addressed at an earlier stage prompted investigation into the broader context of the disaster, with specific focus on the organisational factors that enabled the shuttle to be deemed safe for launch.

The nature of the disaster, coupled with revelations regarding NASA's organisational culture, led to the coining of the term 'Normalisation of Deviance' (NoD) as a means of describing an individual/groups general acceptance of deviant actions or observations (Vaughan 1996). Since its inception, the concept has seen extensive application across a broad range of industrial sectors, and has been used to explain a number of other high profile industrial incidents (e.g. Texas City Refinery [Dechy et al., 2018], Northwick Park drug trial [Hedgecoe, 2014]). The concept's widespread application has however resulted in segmentation across the topic's literature, with little direct crossover between industrial sectors, and a lack of a comprehensive literature synthesis. In order to address this, the present systematic review aims to compile and analyse the present literature on the topic of NoD within high-risk industries and demonstrate the literature's current theoretical conceptualisation of NoD.

1.1 The Space Shuttle Challenger Disaster

A key finding outlined by the investigation into the Space Shuttle Challenger Disaster was that NASA and their engineers were in fact aware of the vehicle's structural weakness.

Signs of erosion on the primary O-rings (rubber seals preventing the escape of hot gases between booster rocket segments) had been noted in 14 of the previous 24 missions across a period of 5 years (Starbuck & Milliken, 1988). In 9 of the final 10 flights prior to the disaster engineers noted erosion on the primary O-rings, as well as evidence of gas leakage in most of these latter cases. The extent of the damage was further exemplified by evidence of erosion on the secondary O-rings, which represented a final safety mechanism and served as a redundant backup (NASA, 1986). These issues were highlighted by engineers on multiple occasions, however NASA managers failed to implement corrective measures, deeming the risk of potential O-ring failure to be acceptable. Following the disaster, one of the managers responsible for the operations of the solid rocket boosters stated:

'Since the risk of O-ring erosion was accepted and indeed expected, it was no longer considered an anomaly to be resolved before the next flight ... the conclusion was, there was no significant difference in risk from previous launches. We'd be taking essentially the same risk on Jan. 28 that we have been ever since we first saw O-ring erosion.' (Bell and Esch, 1987, p. 44, 47)

While the presence of the problem and its implications were acknowledged, the prior accumulation of successful launches fostered a tolerance towards the risk posed, enabling the issue to become relatively normalised. In spite of the increasing frequency and magnitude of erosion, as well as evidence of improper functioning, sub-contractor Thiokol suggested to NASA that the O-ring situation be considered 'closed' (Starbuck & Milliken, 1988). They presented the belief that it did not endanger flight safety and that the problem would not be resolved any time soon. This is particularly noteworthy given that the O-rings had previously been categorised as a "Criticality 1" component, wherein component failure is deemed likely to result in the loss of life or vehicle (NASA, 1986). Though the Criticality 1 of the O-rings was acknowledged as a launch constraint, it was consistently waived and rationalised as

acceptable in light of prior mission successes (Starbuck & Milliken, 1988). Even on the eve of the launch, sub-contractor engineers who expressed concern over the potential for improper sealing under the low forecasted temperatures (-1°C) were informed that they would need to provide evidence for their claims (Starbuck & Milliken, 1988). The engineers did not have enough data to determine adequate functioning of the O-rings below 12°C due to a lack of tests. This was not regarded by the leadership as adequate cause for delaying the launch, a reluctance likely exacerbated the occurrence of multiple previous delays (Starbuck & Milliken, 1988).

1.2 Normalisation of Deviance (NoD)

Within organisational contexts, safety culture describes an organisation's collective underlying employee beliefs and values regarding personal and group responsibilities for safety and risk management (Everson et al., 2020). In reviewing the course of events preceding the Challenger disaster, it appears the O-ring failure merely represents the final fault within a sequence of issues on part of NASA's organisational system. Internal pressures stemming from financial costs, efficiency, political and managerial demands, in concordance with increasing complacency and overconfidence, compromised the organisation's safety culture and facilitated patterns of procedural deviations and risk acceptance. Diane Vaughan, a sociologist investigating the latent causes of the Challenger incident, coined the term 'Normalisation of Deviance' (NoD) to describe how the compromised safety culture of NASA propagated itself to the point of disaster.

Vaughan (1996) defined NoD as the gradual process wherein, in the absence of perceived losses or harm, deviant practices become acceptable. A prominent feature of the phenomenon is the desensitisation process, wherein frequent engagement in deviant practices facilitates the practice's normalisation and perceived standardisation within everyday

operations. This normalised perception sets a new precedent for what is viewed as tolerable and routine, establishing a new normal from which further deviations may occur. In the absence of external intervention (e.g. external audits, change in procedures), this cycle of deviance is disrupted only when deviant behaviour incurs an undesirable outcome.

According to Vaughn (1996), this process of normalised deviance provided the foundation for the Challenger disaster. The theory speculates that successes in the absence of overt negative consequences may cause an organisation's members to develop overconfident perceptions of infallibility towards their existing programmes, procedures, and leadership. In the case of the Challenger, risks associated with the shuttle's structural flaws, though likely a cause for concern to external observers, became imperceptible to many within the organisation itself. Dillon et al. (2013), showcases this phenomenon in a temporal mapping of shuttle mission anomalies reported before and after each of the major disasters of the NASA programme: Challenger in 1986, and Columbia in 2003. Data indicate a downward trend in reported anomalies over time, with initial missions displaying a far greater incidence of reporting by comparison to subsequent missions that preceded the disasters. The authors suggest the decrease in anomaly reporting likely resulted from anomaly normalisation rather than resolution. With the accumulation of successful missions, some occurrences initially deemed anomalous became accepted as normal facets of operations and were no longer reported; implying that the more frequently an anomaly or near miss was observed without serious consequence, the greater the perception that no significant threat was being posed.

The progressive downgrading of anomaly importance was also discussed in the report published by the Columbia Accident Investigation Board (CAIB) (2003) following the Space Shuttle Columbia disaster. As with the Challenger, the downing of the Columbia resulted from a known issue; the shedding of insulation foam from one of the fuel tanks, previously observed within at least 30 prior missions (CAIB, 2003). While originally considered an in-

flight anomaly, it does not appear to have been deemed a serious risk to flight safety. In fact, the frequency of observed shedding caused its significance to be downgraded from an in-flight anomaly to a so-called 'action item' only months prior to the disaster (CAIB, 2003). On the first of February 2003, a piece of foam debris hit the wing of Space Shuttle Columbia, puncturing a hole in the leading edge of the wing, and causing damage which proved terminal upon re-entry into the atmosphere.

1.3 System Approach

Following the aftermath of the Challenger disaster, work by Vaughn proved a crucial contribution to the growing literature looking into accident causation as a product of complex systems. Banja (2010) notes that major disasters such as those of the space shuttles cannot be attributed to singular actions or individuals. They instead require the commission of numerous, often innocuous, mistakes which breach the organisation's defences. On this basis, it was understood that investigations and interventions should focus on systematic or latent errors, rather than attempt to pinpoint active individual errors. Reason (2000) describes how these latent errors foster an environment where error provoking conditions (e.g., time pressure, inexperience, etc.) increase the likelihood of active failures (e.g., slips, procedural violations, etc.), whilst also undermining established safety measures that typically prevent hazards from resulting in losses (e.g., untrustworthy alarms, poorly designed procedures, etc.). The shuttle disasters, though physically speaking the product of technical failures, stemmed from issues relating to cognitive biases, i.e., the human vulnerability for systematic errors in information processing, perception and subsequent decision making (Kahneman, 2011). High-risk environments such as that of NASA, where technical problems and anomalies are the norm rather than exception, are therefore particularly vulnerable to fostering desensitised perceptions of risk.

1.4 Industrial Application

Following its inception within the aerospace industry, the concept of NoD has seen widespread application across numerous other high-risk industries, including oil and gas (Bogard et al., 2015), nuclear (Sanne et al., 2012), aviation (Paletz et al., 2009), and healthcare (Banja, 2010). As in the space shuttle disasters, the concept has been utilised to explain how deviant behaviours may become normalised within organisational contexts. Individuals engaging in deviant actions often appear largely unaware of their deviations or feel their deviance is justified; in either instance, their ability to accurately perceive and comprehend risk is compromised (Banja, 2010; Cavnor, 2018; Hase & Phin, 2015). Given the hazards, intrinsic safety concerns, and production pressures prevalent among high-risk industries and work environments, there is considerable interest in understanding the human mechanisms that may unknowingly propagate and facilitate unwanted outcomes.

Reviews of research into other phenomenon such as teamwork and design characteristics have highlighted the significance of context-based variations with regards to industrial factors such as technology level, focus of service and the nature of production (Carter et al., 2018). To fully understand and utilise the NoD concept it is therefore important to synthesise research across a number of relevant high-risk domains to help ascertain the boundaries of the phenomenon and identify relevant commonalities, potential outliers, and general areas of interest that may help guide future research and intervention.

1.5 Aim

In recent years there has been a notable increase in the quantity of research papers on the topic of NoD from within various industry contexts. However, the majority of this research has been conducted independently and in isolation, leading to the potential splintering in approaches across different industries and the lack of a defined overall theory.

To date, an extensive synthesis or compilation demonstrating the state of the literature has not been conducted. This is particularly noteworthy given that the category of high-risk industry is broad and highly varied, encompassing a diverse range of production aims, operating environments, and associated risks. As such, a systematic review across this category is needed to critically analyse and present how the concept of NoD has been applied within different settings and examine whether differences exist in proposed theory, application, or intervention. The present systematic review aims to collate the existing literature in order to identify commonly discussed themes, components, and potential gaps within the current literature. In order to synthesise our findings effectively we aimed to develop a preliminary conceptual model that would represent the manifestation and propagation of the NoD phenomenon within high-risk industry contexts.

2 Method

2.1 Search Method

The literature search was conducted in February 2021. Four major databases were searched (Scopus, ProQuest, Web of Science, and Science Direct), using search terms: "normalization of deviance" OR "risk normalization" OR "normalization of risk" OR "deviance normalization" OR "normalisation of deviance" OR "risk normalisation" OR "normalisation of risk" OR "deviance normalisation". Risk normalisation terms were included in the search criteria due to its close association with NoD. All search results were then compiled, with all inter and intra database duplicates removed. The total number of unduplicated search results was 147.

2.2 Selection Process

Based on the search criteria, 147 papers were identified. A two-step sifting process was then undertaken as seen in Figure 1. Both sifting stages involved the application of exclusion criteria based on the title and abstract of the identified papers (as recommended in Siddaway et al., 2019). At the first stage, exclusion criteria related to the availability of the text, with four search results removed due to the unavailability of both the abstract and full text. A further 27 results were removed for being unrelated to NoD or risk normalisation, as defined by Vaughn (1996). Specifically, these studies focused on biological normalisation.

Of the remaining 106 search results, a further 39 were removed during the second sift where, based on the title and abstract, papers were excluded if they did not investigate NoD within high-risk industries. This choice of exclusion was due to the present reviews' focus on investigating safety related deviations specifically within high-risk industries. While the NoD phenomenon is applicable across other industrial settings (e.g., finance, project management, retail, etc.) the motivations and consequences for deviating and risk normalisation are likely to differ in the absence of overt physical safety concerns (Banja, 2010). High-risk industries therefore present a varied, but somewhat more homogenous, industry focus that more closely reflects the environment of NASA from which NoD originates. For the purposes of the present review, high-risk industries were defined as falling into categories such as transport (aviation and rail), healthcare and process industries. As such, papers were excluded from further analysis if either the high-risk industrial setting was not apparent from the abstract, or if both industry and safety were not referenced in a relevant capacity.

At the final selection stage, the full text of the remaining studies was interrogated. Studies for which the full text was inaccessible or unavailable (20), were removed. The full texts of the remaining studies were then analysed against the criteria from the initial sifts, with the further removal of studies which did not refer to NoD or risk normalisation within

the text. Four studies were removed due to a lack of clarity on the application of the concept, with insufficient detail available for meaningful analysis. To avoid repetition and maintain focus on the development of the phenomenon since its inception within the aerospace industry, a further four studies were excluded for solely discussing NoD with reference to the space shuttle disasters. Finally, studies focusing on the normalisation of deviance with no focus on safety were also excluded from further analysis.

Figure 1

Literature selection process flow chart.

3 Analysis

The outlined selection process identified 34 articles meeting all inclusion criteria. Studies are categorised in Table 1 on the basis of their industry focus, source type, and country of origin. To comprehend the complex internal dynamics of high-risk industries, analysis required that the literature be broken down into comprehensive conceptual categories/components. As suggested by Hsieh and Shannon (2005) a directed content analysis approach (a method for summarising large quantities of text via fewer content categories [Weber, 1990]) was used in order to validate and conceptually expand upon the existing theory of NoD by Vaughan (1996). This theoretical conceptualisation of the phenomenon was used as a guide for the initial identification, coding, and categorisation of data, as well as the subsequent development of an initial conceptual framework intended to encapsulate the interactions between the identified components.

Given that the majority of the identified literature did not solely focus on the phenomenon of NoD, the coding strategy within the present review required the initial identification of relevant text extracts from within each paper (as suggested in Hsieh & Shannon, 2005). These were identified by reading through the entire text and extracting sections which, directly or implicitly, referenced and/or discussed the NoD phenomenon. Sections were gathered and organised in a Microsoft Word document and were then coded by the first author on the basis of their semantic meaning, relevance, and relationship to NoD. Extract coding and subsequent categorisation followed an inductive approach, with each code being generated on the basis of the content of the identified extracts (n=25). Extracts and initial codes were discussed with the research team to explore the potential higher-order categories (n=10), which were developed through the amalgamation of semantically/categorically similar codes (Elo & Kyngäs, 2008). Through the process of abstraction (Elo et al., 2014), these categories were further refined until representative

overarching categories encompassing the phenomenon as described and discussed across the identified literature were developed (n=7). Individual category names were determined by conventional terminology used within the texts (e.g. production pressure, leadership), or were generated using phraseology intended to describe the category's subject matter (e.g. lack of negative consequences).

To encapsulate the identified components from the current review and portray the nature of their interactions as illustrated across the identified literature a conceptual framework was developed (as seen in Figure 2). The showcased component interactions within the framework were developed inductively through the re-reading of coded excerpts and the identification of reported links and interactivity.

The following excerpt from Arendt and Manton (2015) offers an example of the type of content that informed this identification:

“In this case, a senior operating manager put extreme pressure on his staff and workforce to generate production and numerous decisions were evident that put safety behind economics. This resulted in a low sense of vulnerability in operating staff due to the apparent priority of safety behind production. The low sense of vulnerability led to a “superman complex” on the part of some operations staff that encouraged workarounds...”

The example excerpt portrays the components of leadership, production pressure and risk normalisation, and indicates their interactions. In this instance, the authors report how leadership actions were directly associated with increased production pressure and a low sense of vulnerability (amalgamated into risk normalisation), resulting in subsequent workarounds among operating staff (deviances). All of these reported links can be noted within the present framework.

Four of the identified components (production pressure, procedure/environment design, leadership, culture) displayed a notable number of interactions between one another and were reported to have similarly influential relationships on other elements within the framework, acting as moderating factors across the stages of NoD. Consequently, while maintained and discussed individually in terms of their features, relevance and influence on NoD, these were grouped together under the broader label of 'Organisational Factors'.

Table 1

Normalisation of Deviance Literature Categorised by Industry Focus, Evidence Type, and Country of Origin.

Authors	Year	Title	Industry Focus	Evidence Type	Country of Origin
Arendt & Manton	2015	Understanding Process Safety Culture Disease Pathologies - How to Prevent, Mitigate and Recover From Safety Culture Accidents	Chemical	Case Study	USA/UK
Banja	2010	The Normalization of Deviance in Healthcare Delivery	Healthcare	Conceptual Article	USA
Bloch & Williams	2004	Normalize Deviance at Your Peril	Process Industry*	Case Study	USA
Bogard et al.	2015	An Industry's Call to Understand the Contingencies Involved in Process Safety: Normalization of Deviance	Oil and Gas	Conceptual Article	USA
Cavnor	2018	Fighting the Fire in Our Own House: How Poor Decisions are Smoldering Within the U.S. Fire Service	Firefighting	Thesis – Observational/ Interview	USA
Creedy	2011	Quantitative Risk Assessment: How Realistic are Those Frequency Assumptions?	Process Industry*	Conceptual Article	Canada
Dechy et al.	2018	Learning Failures as the Ultimate Root Causes of Accidents	Generalised Industries**	Conceptual Article	France

Authors	Year	Title	Industry Focus	Evidence Type	Country of Origin
Everson et al.	2020	Exploring Production Pressure and Normalization of Deviance and Their Relationship to Poor Patient Outcomes	Healthcare	Meta-synthesis	USA
Furey & Rixon	2018	When Abnormal Becomes Normal: How Altered Perceptions Contributed to the Ocean Ranger Oil Rig Disaster	Oil and Gas	Case Study	Canada
Geisz-Everson et al.	2019	Cardiovascular Complications in Patients Undergoing Noncardiac Surgery: A Cardiac Closed Claims Thematic Analysis	Healthcare	Incident Report Analysis	USA
Golinski & Hranchook	2018	Adverse Events During Cosmetic Surgery: A Thematic Analysis of Closed Claims	Healthcare	Incident Report Analysis	USA
Hase & Phin	2015	The Normalisation of Deviance in the Oil and Gas Industry: The Role of Rig Leadership in Success and Failure	Oil and Gas	Conceptual Article	UAE
Hedgecoe	2013	A Deviation From Standard Design? Clinical Trials, Research Ethics Committees and the Regulatory Co-construction of Organizational Deviance	Healthcare	Case Study	UK
Heimann	2005	Repeated Failures in the Management of High Risk Technologies	Generalised Industry**	Conceptual Article	USA

Authors	Year	Title	Industry Focus	Evidence Type	Country of Origin
King	2010	To Err is Human, to Drift is Normalization of Deviance	Healthcare	Conceptual Article	USA
Mast	2018	Summary of the King County, Washington, West Point WWTP Flood of 2017	Process Industry*	Case Study	USA
McNamara	2011	The Normalization of Deviance: What are the Perioperative Risks?	Healthcare	Conceptual Article	USA
Mize	2019	The Roundabout Way to Disaster: Recognizing and Responding to Normalization of Deviance	Chemical	Case Study	USA
Naweed et al.	2015	Are You Fit to Continue? Approaching Rail Systems Thinking at the Cusp of Safety and the Apex of Performance	Rail	Risk Analysis – Observational/ Interview	Australia/New Zealand
Naweed & Rose	2015	It's a Frightful Scenario: A Study of Tram Collisions on a Mixed-Traffic Environment in an Australian Metropolitan Setting	Rail	Risk Analysis – Observational/ Interview	Australia
Odom-Forren	2011	The Normalization of Deviance: A Threat to Patient Safety	Healthcare	Conceptual Article	USA
Paletz et al.	2009	Socializing the Human Factors Analysis and Classification System: Incorporating Social Psychological Phenomena into a Human Factors Error Classification System	Aviation	Risk Analysis - Interview	USA

Authors	Year	Title	Industry Focus	Evidence Type	Country of Origin
Pannick et al.	2017	Translating Concerns Into action: A detailed Qualitative Evaluation of an Interdisciplinary Intervention on Medical Wards	Healthcare	Intervention Evaluation – Observation/ Interview	UK
Price & Williams	2018	When Doing Wrong Feels so Right: Normalization of Deviance	Healthcare	Conceptual Article	USA
Prielipp et al.	2010	The Normalization of Deviance: Do We (Un)Knowingly Accept Doing the Wrong Thing?	Healthcare	Conceptual Article	USA
Quinn	2018	When “SOP” Fails: Disseminating Risk Assessment in Aviation Case Studies and Analysis	Aviation	Conceptual Article	USA
Ruault et al.	2013	Sociotechnical Systems Resilience: A Dissonance Engineering Point of View	Rail	Case Study	France
Sanne	2012	Learning From Adverse Events in the Nuclear Power Industry: Organizational Learning, Policy Making and Normalization	Nuclear	Conceptual Article	Sweden
Scott et al.	2017	Countering Cognitive Biases in Minimising Low Value Care	Healthcare	Conceptual Article	Australia
Simmons et al.	2011	Tubing Misconnections: Normalization of Deviance	Healthcare	Meta-synthesis	USA

Authors	Year	Title	Industry Focus	Evidence Type	Country of Origin
Stave & Törner	2007	Exploring the Organisational Preconditions for Occupational Accidents in Food Industry: A Qualitative Approach	Food Industry	Conceptual article	Sweden
Stergiou-Kita et al.	2015	Danger Zone: Men, Masculinity and Occupational Health and Safety in High Risk Occupations	Generalised Industry**	Critical Literature Review	Canada
Tinsley & Dillon-Merrill	2005	Whew That Was Close: How Near-Miss Events Bias Subsequent Decision Making Under Risk	Oil and Gas	Experimental Study	USA
Wilbanks et al.	2018	Transfer of Care in Perioperative Settings: A Descriptive Qualitative Study	Healthcare	Incident Report Analysis	USA

Note.

** Industrial focus identified solely as process industry.*

*** Study either has no specific industrial focus, or the focus is not stated.*

4 Discussion

The aim of the present systematic review was to synthesise the existing literature on the topic of safety related NoD within high-risk industrial settings. It is made evident throughout the literature that the nature of deviance and NoD is highly complex within industry contexts, wherein a multitude of factors pertaining to organisational, social, and technical processes contribute to the phenomenon (Cavnor, 2018). These are influential to the development and propagation of NoD across its different stages. Factors such as production pressure have the potential to influence a range of outcomes, including the likelihood of normalising risk, the likelihood of deviating from set procedures, and the likelihood of initiating a pre-emptive response following a deviation. Within the present review we have represented these interactions through the use of an initial conceptual framework which expands upon previous models of NoD by integrating the phenomenon of risk normalisation. While these findings are only preliminary, and somewhat limited by the scope and nature of the phenomenon's academic literature, the framework may help in guiding further analysis with primary data sources.

Figure 2

Conceptual framework of Normalisation of Deviance based on the present systematic review.

Note. (n) represents the number of individual studies within which the category was identified.

4.1 Conceptual Framework

The conceptual NoD framework (Figure 2) offers a visual representation of the flow path an organisation or a group may take from normal operations to the onset of a loss event as illustrated across the identified literature. As within previous models (Hajikazemi, 2020; Heimann, 2005), the present framework illustrates a cyclical progression, where the propagation of NoD is essentially self-sustaining. The cycle is maintained by the factors and conditions present within a given system, in this instance the high-risk industry context. In the absence of losses or negative consequence, and without adequate pre-emptive response to near-miss events, deviations and their associated risks become normalised through a feedback loop influenced by prevailing organisational factors, e.g., procedural shortcuts/corner cutting repeatedly carried out in order to benefit production outputs. In this regard, individual instances of deviations may not be explicitly harmful, rather, it is the cumulative degradation of operating procedure that increases the likelihood of a major loss event.

Each of the identified framework components is defined and explored in relation to the relevant literature. These components should be understood as largely non-linear in their interactions, wherein the degrees of overlap and cumulative contribution are likely to vary depending on the specific industry contexts. For theoretical purposes, it should be assumed that the initial development of NoD within organisations begins when a pattern of deviating from an initial procedural baseline is first sustained.

4.1.1 Risk Normalisation

Existing literature typically uses the term risk normalisation to describe the desensitisation to risks present within one's environment, and in broader contexts offers explanation for how societies come to accept known risks in order to remain operational. Schweitzer and Mix (2018), for example, discuss how risks associated with nuclear energy

were largely normalised within French mainstream media in response to the 2011 Fukushima disaster. Public support for nuclear energy was generally unfazed following the incident, which Schweitzer and Mix rationalise to be largely due to the nation's heavy dependence on nuclear energy. Similarly, Luís et al. (2015) observed that increased awareness of coastal hazards appeared to inversely correlate with perceptions of risk regarding the phenomena; an effect which was particularly strong among permanent coastal residents. In this regard, normalisation of risk may be largely seen as an adaptive response, facilitating functionality in the presence of circumstances outside one's control (Stave & Törner, 2007). In the industrial context, Stave and Törner refer to a number of organisational preconditions that aid in normalising the presence of risk, citing, for example, how operators are often assigned high levels of personal responsibility despite possessing low levels of actual control over their environments and performance of tasks.

A core feature of the present theoretical framework is its integration of risk normalisation within the NoD phenomenon, with risk normalisation being accounted for as a contributory precursor to the initiation and subsequent acceptance of deviances. Though deviances may occur in the absence of risk normalisation, it is unlikely that behaviours will be repeated if their associated risks are continuously perceived to be high. Risk normalisation thus requires that individuals develop an increased risk threshold/tolerance wherein they lose the ability to accurately perceive vulnerabilities within their physical or procedural operating systems.

Periods of perceived successes, or at a minimum, periods absent of negative events may further encourage a loss of perceived vulnerability by increasing complacency and overconfidence in the safety of operations and environment (Hase & Phin, 2015; Mast, 2018). Organisations that maintain a history of successes may come to be perceived as “too big to fail” (Hedgecoe, 2014). Arendt and Manton (2015), describe this as a “superman complex”,

wherein a lack of attention to risk and safety prevents workers from perceiving vulnerabilities within themselves and their environment. Banja (2010) clarifies this illusion of invulnerability in pointing out that inherent system deviations, flaws, and weaknesses are generally inevitable, it is however the unpredictability and infrequency with which these result in serious incidents that encourages complacency.

Under such circumstances, desensitisation to hazards can lead to the acceptance of increasing levels of risk. Hase and Phin (2015) describe this process as relatively mundane, innocuous, and largely imperceptible, given the gradual manner in which it develops. Creedy (2011) moreover highlights the temporal nature of the phenomenon in observing how deviations in standard operating procedure often parallel the time elapsed following a past incident. Paletz et al. (2009) similarly outline the dangers of complacency among experienced pilots, who report becoming accustomed to the risks of flying in bad weather conditions and demonstrate greater engagement in risky behaviour than their less experienced counterparts.

An additional variable that has been noted to impact perceptions of risk is the introduction of new protective measures, or system safety barriers. These represent the physical and non-physical initiatives used to enhance the safety of operations and mitigate unwanted outcomes. The introduction of a new protective measure generally increases perceived safety, which may unwittingly encourage employee perceptions of system invulnerability (Mize, 2019; Prielipp et al., 2010). In other words, new protective measures may be viewed as solutions rather than fail-safes to known problems. Their introduction may therefore incentivise deviations in an attempt to bypass prior safety demands and maximise production efficiency (Banja, 2010; Mize, 2019; Prielipp et al., 2010).

4.1.2 Organisational Factors

4.1.2.1 Production Pressure

Production pressure refers to the emphasis on output efficiency, typically at the expense of safety (Everson et al., 2020). Throughout the reviewed literature production pressure is often discussed as a major contributor to NoD and is commonly cited in organisational contexts as a moderating variable that guides the direction and magnitude of deviations. Cavnor (2018) describes production and safety as antagonist agents, whereby increased attention to one often causes detriment to the other. This idea is discussed further by Heimann (2005) with reference to type I and type II errors. In principle, high-risk industries are often cited as being averse to committing Type I errors (active errors of commission), where implementing an incorrect policy or course of action results in failure. Heimann (2005) notes that Type I error aversion is indeed often present initially within organisations, who typically begin operating with low thresholds of risk tolerance so as to create the impression of a functionally safe system. Under such conditions accidents are generally infrequent and less severe, which encourages focus to shift towards the elimination of Type II errors of omission, e.g., use of unnecessary measures that are costly to efficiency and productivity. This desire for increased productivity and efficiency acts as the driving force for deviations and shortcuts to be undertaken by operators (Dechy et al., 2018).

In the absence of immediate negative outcomes, organisations and individuals may become susceptible to the aforementioned influence of risk normalisation, and may feel justified in re-evaluating and altering their potentially costly and overly ‘conservative’ thresholds. As a result, a so-called “cycle of failure” is propagated, wherein continued deviation from initial standards in pursuit of efficiency ultimately culminates in major failure (Heimann, 2005).

Naweed et al. (2015) and Naweed and Rose (2015) reference how organisations within the rail industry emphasise punctuality and ‘on-time performance’, describing the heightened pressure experienced by operators running behind schedule as a condition under which they report greater susceptibility to taking shortcuts and violating procedures to recover lost time. Specifically, Naweed et al. (2015) note that driver interpretation of signals has shifted over time in order to facilitate faster train movement. This behaviour has increased the likelihood of ‘signal passed at danger’ (SPAD) events, wherein a train passes a stop signal without explicit allowance to do so; a practice which, when performed frequently, is associated with an increased risk of derailment or collision.

Pressures associated with having to accomplish more with less are exemplified in a number of other cases throughout the literature, such as Mize (2019) who outlines a case of operators within a chemical plant violating standard procedure to meet increasing production targets, and Cavnor (2018) who notes evidence of firefighters skipping safety checks prior to entering compromised structures to achieve tactical goals more efficiently. Within healthcare, McNamara (2011) and, Arendt and Manton (2015) cite managerial and institutional pressures on productivity and maintenance of the operating room on schedule as factors typically accountable for the introduction of deviations. Clinicians may, for example, disconnect vitality monitors prior to the end of a procedure, or before a patient has fully emerged from anaesthesia, in order to speed up the turnover process (Prielipp et al., 2010). However, Bogard et al. (2015) state that these shortcuts and deviations rarely result in serious process safety issues and often directly facilitate the organisation's target progression.

It is important to also acknowledge however that the relationship between production pressures, safety, and Type I and II errors varies across individual industries. Specifically, it is somewhat more complicated in occupations such as healthcare and firefighting where circumstances may cause production pressures to be explicitly tied to physical safety. In

these contexts, both Type I and Type II errors may result in harm or loss of life, either through initiating incorrect/unsafe treatment, or withholding correct treatment (Price & Williams, 2018). In this regard, motivations for deviating may differ in some respects from traditional process industries given that production demands are directly concerned with minimising harm done. Insights from clinician reports regarding their rationale for procedural deviations reflect this, with individuals often citing a desire to minimise patient discomfort and eliminate unnecessary or counterproductive measures as being justification for procedural deviations (Banja, 2010; Scott et al., 2017).

Deviations guided by a patient-centric or ‘greater good’ approach may easily provide justification for the normalisation of shortcuts, given the perception that these ultimately offer a means of attending to more patients, or provide the opportunity to prioritise those with more serious conditions (Price & Williams, 2018). Cavnor (2018) similarly notes a form of ‘melioration bias’ (a tendency towards alternatives seen as preferable in the short-term) in regard to certain operating procedures; namely the correct wearing of PPE, which firefighters have claimed hinders movement and impedes life-saving action.

Among process industries, common generalised instances of justified deviance may be observed in shortcuts performed by operators seeking to improve productivity; not for explicit and immediate personal gain, but rather as a means of satisfying broader organisational demands (Mize, 2019). These deviations, intended to maximise productivity, may be further compounded by a pre-existing rule ambiguity and unfamiliarity, particularly for tasks that do not involve standardised checklists (Banja, 2010; Mize, 2019; Stergiou-Kita et al., 2015).

4.1.2.2 Procedure/Environment Design

Inappropriate implementation of procedure and poor environmental design are factors cited as contributory to the initiation and maintenance of deviant behaviour. Under time and

production constraints, procedural or environmental limitations may often provide justification for deviances and violations (Mize, 2019; Price & Williams, 2018); with some operators arguing that perfect compliance to rules and standards makes it impossible to achieve productivity demands (Banja, 2010). Price and Williams (2018) state that the very presence of deviance inherently signals towards potential flaws within a system's environment or work process. In reference to healthcare, they illustrate how factors such as inconveniently placed hand hygiene stations decrease hygiene compliance, and even minor obstacles such as malfunctioning barcode scanners disrupt entire workflows and prompt the skipping of the scanning process in order to achieve on time administration of medication.

In some organisations, Quinn (2018) argues that rather than amending poor procedure and environmental design, deviances become a normalised and expected practice intended to “fill in the gaps” of standard operating procedures. In other instances, there may be an initial lack of overt procedural rules or adequate resources which precipitates compensatory individual and team solutions (Cavnor, 2018; Hedgecoe, 2014; Stave & Törner, 2007).

A further weakness explicitly referenced within the literature is that of maladaptive alarm/warning system design resulting in the experience of alarm fatigue. Bogard et al. (2015) highlights how overexposure to alarms causes desensitisation and loss of vulnerability towards these. Frequent alarm exposure, particularly when false, normalises the alarm presence as routine, prompting a lack of response. Poor implementation of an alarm system may also encourage procedural deviations intended to circumvent system activation, as evidenced in the railway industry where cautionary signals have been largely devalued by drivers. Naweed et al. (2015) reports that on some journeys it is routine to operate in a continuous “alarmed” state without ever being clear of cautionary signals.

4.1.2.3 Leadership

Everson et al. (2020) describe the nature of an organisation's safety culture to be largely determined by the approaches taken by executive leadership. Mize (2019) notes that it is the leadership of an organisation that is responsible for setting expectations for employee attitudes and behaviour, with the responsibility of providing sufficient training and reinforcement of operational discipline. In this regard, leadership failures in the maintenance of a system's risk mitigation often play a crucial role in facilitating NoD (Bogard et al., 2015). Actions by leadership are generally perceived as having top-down consequences, wherein poor leadership decisions are filtered through the various levels of an organisation, causing damage to an organisation's operational safety and general safety culture (Hase & Phin, 2015).

Supervisors may for example avoid or choose not to discipline operators who engage in shortcuts and deviations in order to simplify processes, reduce workloads and increase production speed (Bogard et al., 2015). In an attempt to conserve resources, some organisations may also fail to provide adequate training by limiting the amount of time available for operators to familiarise themselves with new tools or procedures (Geisz-Everson et al., 2019), or in some cases, through the active teaching of already normalised shortcuts and deviations (Banja, 2010; Oddom-Forren, 2011). A key issue here is that in such instances deviations performed by authority figures typically go unchallenged (McNamara, 2011).

Actions such as these facilitate NoD by instilling a "production over safety mindset" when led by the example of decision-making authority figures (Cavnor, 2018). When an organisation places excessive demand on economics, leadership may fail to uphold process safety as a core value, resulting in the dismissal of warning signs and the encouragement of workarounds in the interest of production (Arendt & Manton, 2015; Dechy et al., 2018). Younger, and more inexperienced employees are particularly vulnerable to production

demands given their limitations in power, agency, and inability to accurately comprehend or question safety procedures (Banja, 2010; Stergiou-Kita et al., 2015). Furthermore, it is suggested that observations of issues and weaknesses may be minimised when reported to supervisors/higher authorities due to a fear of repercussion or punitive action from leadership and/or a general lack of confidence that voicing concerns would lead to actual change (Banja, 2010; Furey & Rixon, 2018; Odom-Forren, 2011).

4.1.2.4 Culture

The present review distinguishes the component of culture as somewhat independent to leadership and production pressure, which may traditionally be considered subsets of the organisational culture. While, as with all the themes discussed, there is likely to be overlap in the actual manifestation of components within real world settings, culture as it pertains to NoD has in many instances been flagged as a unique contributor to the phenomenon (Cavnor, 2018). Organisations are commonly cited as possessing individual identities that dictate group dynamics within work settings. These social identities, while influenced by organisational demands, exist independently as products of an organisation's history, projected image, and working environment. Cavnor (2018) for example, extensively discusses the cultural and social implications of firefighting, describing how beliefs shared among firefighter groups often encourage behaviours that favour risk acceptance. As a result, authors have frequently identified the importance of understanding culture as a variable that may inadvertently sustain unhelpful practices (Hase & Phin, 2015; Price & Williams, 2018).

Culture describes the collective nature of an organisation's underlying values, beliefs, expectations, and perceptions which guide and inform individual and group behaviours and practices (Everson et al., 2020). An organisation's history, externally projected image, and working environment, are of particular significance to culture, as these often become integrated with the individual identities of work personnel, fostering traditions and

operational practices that may be both adaptive and maladaptive (Cavnor, 2018). Price and Williams (2018), for example, note how healthcare workers traditionally promote a standard of individual perfection that ultimately distracts from addressing wider underlying issues relating to equipment, systems, or procedure. Similarly, the distinct social image of firefighters may promote mutual trust, courage, and concern for the safety of others, however it may also encourage excessive and unreasonable risk-taking (Cavnor, 2018; Stergiou- Kita et al., 2015).

In this regard, Hedgecoe (2014) notes that the everyday culture of work groups may often inadvertently accommodate and normalise risk; leading organisational cultures to foster environments where normalised deviances are mundane occurrences rather than exceptions (Hase & Phin, 2015). Stave and Törner (2007), describe the working practices of a team as the product of continuous internal negotiations, which may lead to risk acceptance within work cultures that do not prioritise safety.

Alternatively, some organisations may also manifest a 'silo effect', characterised by a lack of cohesion and interaction between workgroups and departments. These experience fragmented individual group cultures, operating on independent standards so as to meet their own needs rather than a common shared agenda across the organisation (Golinski & Hranchook, 2018). This may result in inconsistent practices across an organisation, wherein a lack of communication perpetuates rule unfamiliarity and deviations in practice which damage the organisation's overall safety and functionality. Thus in spite of the aforementioned potential for unwanted consequences, a shared social identity among employees is therefore still typically seen as desirable within the organisational context (Golinski & Hranchook, 2018).

4.1.3 Lack of Negative Consequences

The absence of negative consequences is an integral element of NoD, discussed extensively in relation to deviance and risk perception desensitisation (Price & Williams, 2018). When deviance fails to result in an apparent adverse outcome, it may be seen as indication of initial standards or procedure being overconservative (Creedy, 2011). This perception justifies deviations as acceptable evolutions of the productive process, wherein behaviour is merely adapting to maximise efficiency. In the absence of consequence such behaviours are prone to repetition (Paletz et al., 2009), and may become accepted by both workers and management throughout the organisation (Bogard et al., 2015); with perceived benefits to production further disincentivising intervention and enforcement of discipline (Bogard et al., 2015). As with loss of vulnerability and risk normalisation, the absence of consequence fosters a ‘presumption of safety’ which impairs collective and individual abilities to comprehend and perceive risk (Hedgecoe, 2014).

4.1.4 Pre-Emptive Response

Pre-emptive response refers to measures taken to anticipate, identify and prevent the propagation of maladaptive deviance. This encompasses both the nature of proactive measures used to detect and respond to near-misses/signals, as well as the quality of retroactive learning following an incident or near-miss (Cavnor, 2018). The importance of identification and learning is particularly relevant given that pre- and post- investigation processes are both susceptible to normalisation biases. Initial signals normalised in advance of an incident may be subject to the same framing after an accident, often in an attempt to cover up wrong-doings and minimise responsibility (Furey & Rixon, 2018; Sanne, 2012). Moreover, signals of potential disaster can manifest at various time intervals and across

varied locations, which may cause individuals within an organisation to view pre- and post-events from a detached personal level (Simmons et al., 2011).

Ideally, behavioural deviances, warning signals and near-misses should always be accounted for. However, in light of the potential associated effort and costs, individuals may be biased towards discounting originally proposed risks when there is a lack of incentive for reporting/speaking up (Banja, 2010; Cavnor, 2018; Sanne, 2012; Tinsley & Dillon-Merrill, 2005). Furthermore, while some organisations outline policies regarding what events need to be reported, criteria are often subjective and dependent upon voluntary input (Dechy et al., 2018).

Another component detrimental to pre-emptive learning is that of inappropriate safety reporting systems. Pannick et al. (2017) describes a healthcare setting wherein the formal mechanism for recording incidents was an online reporting system that was difficult to use and poorly suited for this purpose, with long delays in the processing of even relatively simple issues; resulting in common/recurrent problems being left unreported and normalised within everyday practice. Failure to document warning signs or procedural changes, even those perceived as positive workarounds and innovations, enables these to remain unchallenged, and set precedents for procedural ambiguity and shifting norms (Mize, 2019). When incident analysis does take place, Price and Williams (2018) specifically outline the importance of appropriate system/process investigation in order to avoid simply blaming individual behaviours or components. They cite how patient safety literature demonstrates the efficacy of addressing issues from a system, rather than human, perspective.

4.2 Industry Comparison

While the healthcare industry represents the largest single industrial sector among the identified literature, many of the core components and patterns of NoD appear largely consistent across the industries accounted for within this review. As mentioned, one of the

primary differences appears to concern factors surrounding production pressures, and more specifically, the nature and motivations regarding industry outputs (i.e. minimising harm versus maximising productivity and efficiency). This difference is however not undermined within the present model, as 'production pressure' is not specific in the type of motivation it describes, but rather refers to any form of medium or motivation by which perceived output demands are prioritised and likely to encourage deviations in practice.

Arguably, these descriptive differences may fundamentally be a simple case of categorisation and semantics; however, given the complexity of organisational contexts and individual experiences, the importance of understanding and accounting for the unique variables within individual organisations should not be understated.

4.3 Theoretical contribution

The current academic literature on the topic of NoD indicates that research has been largely independent and fragmented across a variety of sectors. The present systematic review synthesises literature from a variety of high-risk industries in an attempt to ascertain common components of the phenomenon and introduce a new conceptual framework that seeks to encapsulate the manner in which the phenomenon has been presented and discussed. One of the main theoretical contributions of the present paper is the integration of risk normalisation within a model of NoD as an integral component in the development and maintenance of the phenomenon. While entirely conceptual at present, this model suggests that intervention methods for the prevention of harmful NoD may need to focus on the initial normalisation of risk; more specifically, ensuring that operator perceptions of risk do not degrade over time. Furthermore, the present review highlights the impact of organisational factors on the propagation of NoD. While these are likely to be context specific and variable, they point towards factors that should be considered when investigating NoD within the high-

risk industry context (e.g. Is production pressure encouraging deviations and short-cuts? Does culture within the work environment discourage the reporting of near misses? etc.).

4.4 Limitations & Future Research

While the present review and conceptual model are based on the current academic literature on the topic of NoD, there are some notable limitations that should be considered. Namely, the model is preliminary and untested, and based on a relatively small sample of academic literature. While a systematic method of analysis was utilised for its creation, with directed content analysis often being used to develop conceptual models (Elo et al., 2014), an inherent level of subjectivity and potential bias exist both in the initial coding and subsequent categorisation and model mapping. This may have been particularly pronounced within the present review where only one coder was used (first author). However, the coder remained open to new and alternative codes or potential categorisations. Future research will address this limitation through testing of the preliminary framework in real-world settings (e.g., case studies)

A further consideration that should be addressed is that NoD with regards to high-risk industry has so far been mostly discussed within the confines of conceptual articles, or on the basis of accident reports and case studies. Of the 34 identified studies within the present review, 21 utilised secondary data, and of the remaining 13, seven were based on case studies. As such, the majority of the reviewed literature consisted of studies that did not present novel data or findings, but rather built upon and discussed the relevant topics from a number of industry perspectives. Though these offer valuable insights and points of consideration, the presence of primary data within this review has been severely limited. The review is therefore confined to focusing on the phenomenon from a largely conceptual and observational standpoint. The lack of applied research on the topic is an issue highlighted by several authors, who acknowledge that many of the observations and speculations, though

theoretically reasonable, are yet to be actively quantified in terms of real-world intervention and risk reduction (Arendt & Manton, 2015; Cavnor, 2018; Creedy, 2011; Bogard et al., 2015).

These limitations suggest testing of the present model is required prior to any serious or consequential application. Specifically, the framework should be tested and quantified with respect to real-life settings and primary data in order to make further refinements and provide validity. This could be accomplished through the analysis of incident reports, or by using primary data obtained from interviews or direct observations. Additionally, applied methods of analysis could be used in order to test specific components of the framework. Of specific interest would be the investigation of the impact of risk normalisation on the likelihood and maintenance of deviations. Such research could have the potential to provide important contributions necessary for the development of NoD intervention methods.

5 Conclusion

The study of NoD is theoretically based on the systems approach to accident causation, wherein emphasis is placed on understanding how dynamic components of a system enable a given phenomenon to manifest and propagate. An important facet of this approach is its emphasis on understanding the impact of latent failures, framing active failures as biproducts of a flawed system rather than vice-versa. The benefit of this perspective is that enables the development of interventions and improvements that can be applicable and generalised across a range of contexts that accommodate similar system dynamics. The present review, which aimed to synthesise the existing literature on the phenomenon of NoD from a range of high-risk industrial sectors, may represent an initial step towards such interventions with regard to the NoD phenomenon and high-risk industry. Using a directed content analysis approach, the present systematic review of 34 articles

synthesises the existing literature and presents its findings within a conceptual framework.

The framework seeks to encapsulate the reported interactions between identified industry components and NoD, while building upon prior examples through the incorporation of risk normalisation. While unable to offer specific interventions, the present paper provides foundations for future applied research on the topic, and offers a common framework for the phenomenon that is applicable across a range of industrial sectors.

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