TOWARD A MORAL FRAMEWORK FOR

IMPROVING RAIL PASSENGER SAFETY: OCCUPANT PROTECTION

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ABSTRACT

The National Transportation Safety Board (NTSB) is charged by the U.S. Congress to investigate significant passenger rail accidents to determine the probable cause and to issue safety recommendations aimed at preventing similar accidents in the future. These safety recommendations are NTSB's primary product for improving transportation safety. The recipients of the safety recommendations, however, do not always accept and follow these recommendations. This creates a safety impasse.

This thesis explores a means to move toward a resolution of this safety impasse, through a moral framework for improving passenger rail safety. The impact of the passenger safety impasse is traced to illustrate the need to address and resolve the safety impasse problem.

To that end, a process for expanding the current post-accident investigation process for improving passenger rail transportation safety beyond the primary, evidence-based product of safety recommendations is provided. A new type of analysis, that is a second duty-based analysis within a moral framework, is developed.

Within the duty-based analysis, the need to ensure safety on public transportation systems is posited as a Kantian Categorical Safety Imperative. From this a requirement is determined: that rail transportation safety measures, whether developed through research and analysis, or through the safety recommendation process, are equitably translated to rail applications that achieve the same safety goals for all people, across all sectors of society, regardless of socio-economic and demographic factors. This is posited as the Translational Categorical Safety Imperative for transportation, which is, to identify and address transportation safety disparities and ensure future transportation safety equity for all.

To my parents, John and Barbara Leopold,

and my family,

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INTRODUCTION

Safe public transportation systems are a vital concern for the public and employees of the companies that operate the transportation systems. In the U.S., the responsibility of achieving and enforcing safety on public transportation systems, such as railway, airline, highway and marine systems, is shared among several stakeholders. These include state and federal government agencies and the transportation industry. Although the stakeholders have a common interest in safety, their unique roles form distinct lenses through which they perceive safety. This can result in conflicting perspectives on safety and lead to delays in safety improvements.

The National Transportation Safety Board (NTSB) is a federal agency charged by the U.S. Congress to investigate significant passenger rail accidents to determine the probable cause and to issue safety recommendations aimed at preventing similar accidents in the future. Safety recommendations are the result of an accident investigation that is a stringent evidence-based process. These safety recommendations are the NTSB's primary product for improving transportation safety. However, the recipients of the safety recommendations do not always accept and follow these recommendations.

This creates a safety impasse, where a federal agency states that actions are needed to prevent future harm to passengers, employees and, sometimes, to the public writ large, and the recipient disagrees and refuses to take action on the safety recommendations. This thesis formulates a path for resolving this safety impasse by working within a moral

framework to propose a normative ethical approach to improving passenger rail transportation safety. This is posited as a Kantian Categorical Safety Imperative. It requires identifying and addressing transportation safety disparities and ensuring future transportation safety equity for all.

First, Chapter One describes the problem of the passenger safety impasse by providing an example of two fatal train derailments at excessive speeds that resulted in a safety impasse between the NTSB and another federal agency, the Federal Railroad Administration (FRA).[1] For the purpose of this dissertation, a safety impasse is a seemingly unresolvable conflict that occurs following a decision by one stakeholder (here, the FRA) to reject a safety initiative from another stakeholder (here, the NTSB). Two of the safety recommendations issued by the NTSB to the FRA, following its investigation of two accidents, and the corresponding negative responses from the FRA, are used to exemplify the safety impasse. These two accidents are the 2015 fatal derailment of an Amtrak passenger train in Philadelphia, Pennsylvania and the 2017 fatal derailment of an Amtrak passenger train in DuPont, Washington. Brief descriptions of the accidents and a timeline for the correspondence between the two agencies are provided.

[1] This thesis uses an example of the safety impasse problem, where the recipient of the safety recommendation is another federal agency. This does not, however, preclude other types of recipients, such as state or local agencies or companies within the transportation industry.

The safety impasse, which evolved following the investigation of the Philadelphia accident, led to a reiteration of safety recommendations following the investigation of the DuPont accident. These safety recommendations again were not accepted by the FRA, and so the safety impasse continued and stands today.

The question now is, how to resolve this safety impasse in order to improve passenger safety?

In response, in Chapter Two a basic schema for the moral process is offered as a framework by which the decision-making that leads to an impasse can be viewed. This is applied to the problem of the formation of a safety impasse and leads to the second finding: a safety impasse is an example of a moral impasse. A moral impasse is defined, and a methodology is proposed to work towards resolving the moral impasse through analysis within a moral framework. This analysis expands NTSB's post-accident investigation process for improving passenger rail transportation safety beyond the primary, evidence-based product of safety recommendations and specifically addresses the problem of a safety impasse.

The third chapter further forms a methodology through developing a new type of safety analysis, that is a duty-based analysis. It consists of two elements: A Harm Assessment and a Normative Assessment. The Harm Assessment is founded on the principle of non-maleficence, or do not harm. The Normative Assessment begins by looking at differences between two areas of normative ethics, the teleological, or results-

based, and the deontological, or duty-based. This illustrates the two differing lenses through which two organizations might approach passenger rail safety. Although these differences lend themselves to forming a dichotomy between a teleological normative approach and a deontological normative approach, this hypothesis is rejected as the causal factor leading to the safety impasse between the NTSB's safety recommendations and the FRA's responses. Instead, through a deeper look it is determined that the safety impasse stems from two divergent views within the deontological normative approach. That is, the formation of the safety impasse occurs when the divergent worldviews of the FRA and the NTSB are applied to address safety recommendations following a passenger rail accident investigation.[2]

The outcome of the analysis is presented as a movement towards the formation of a societal Categorical Safety Imperative, as an instance of a Kantian Categorical Imperative, which may serve as a guide for resolving safety impasses. Chapter Three concludes by addressing a second question; why doesn't the railroad follow the NTSB's safety recommendations on its own, without being required to via new federal regulations from the FRA? In response, the railroad is viewed as having a teleological utilitarian approach to rail safety and the normative Safety Imperative is offered as a starting point for influencing a new direction, through a moral framework, to improve passenger rail safety.

[2] These worldviews are Deontological Conditional Imperative for the FRA and Deontological Categorical Imperative for the NTSB. These terms will be defined in Chapter Three.

The fourth chapter looks at implications for future expansions of a moral framework for improving rail passenger safety based on normative values. This focuses on two future assessments, the Corporate Assessment and the Public Safety Assessment. The former examines actions and plans of corporate stakeholders using environmental, social and governance criteria. The latter examines public safety from a broad societal view and assesses plans and actions of public safety stakeholders using societal safety disparity and safety equity criteria. Examples are provided based on the emergent issues arising from the COVID-19 pandemic and a need to assess potential transportation safety disparities in a parallel manner to the health disparities research performed in the medical field.

These two examples lead to the following conclusion; that moving toward a resolution of a moral safety impasse exposes the need for adopting a Kantian Categorical Safety Imperative, with the goal of achieving safety equity. That is, the same minimum safety outcomes for all people, across all socio-economic and demographic factors. Safety outcomes are measured as the number of passenger injuries and fatalities. With this in mind, the importance of ensuring that rail transportation safety measures, whether developed through research and analysis, or through the safety recommendation process, are translated to rail applications that achieve the same safety outcomes for all people, across all sectors of society, regardless of socio-economic and demographic factors. This is posited as the Translational Safety Imperative for transportation. A three-step process

is offered; to identify and resolve transportation safety disparities and ensuring future transportation safety equity for all. That is, to achieve the Categorical Safety Imperative for transportation.[3]

[3] I wish to acknowledge, with gratitude, that funding for my doctoral coursework that supports this Thesis was provided by the National Aeronautics and Space Administration and Georgetown University Medical Center. The views expressed are my own.

CHAPTER ONE

THE PROBLEM OF THE PASSENGER SAFETY IMPASSE

Chapter One examines passenger rail safety risks and mitigation, focusing on fatal train accidents with derailments and rollovers. First, the concept of a Safety Impasse is introduced. It is followed by sections on: two fatal rail accidents (in Philadelphia, PA and DuPont, WA), a timeline of events leading to the safety impasse, a human factors psychology review of the FRA's passenger protection research, and a final section on what leads to a safety impasse.

Example of a Safety Impasse

This section examines the safety aftermath of two fatal rail accidents on Amtrak passenger trains. Amtrak is the commercial passenger rail transportation provider for medium and long-distance intercity routes in the contiguous United States.[1] Since its formation in 1970, Amtrak has had accidents resulting in passenger fatalities and severe injuries. Two of these accidents, investigated by the NTSB, are discussed in this chapter.

Amtrak has implemented some passenger safety measures, such as rail car crashworthiness through engineering designs, risk mitigations of better window retention,

[1] Amtrak was formed in 1970 with the Rail Passenger Service Act (Pub. L. 91–518, H.R. 17849, 84 Stat. 1327, enacted by Congress on October 30, 1970). The railroad is owned by the federal government, run as a for-profit organization, and receives federal and state subsidies to operate a national network of inter-city passenger rail systems.

improved interior lighting and signage, and compartmentalization. These safety measures have only partially mitigated the risk of injury and fatality. Window retention is a method to prevent passenger ejection from the rail car when they are displaced during a train accident. Interior lighting and signage are methods to assist passengers' egress from rail cars when an emergency occurs. Compartmentalization is a method of preventing passenger displacement using seat design features of close spacing, high backs, and energy absorbing padding, to better protect passengers.[2] Amtrak has not implemented passenger safety measures, such as seatbelts, to keep passengers and their belongings from being ejected from their place during an accident.

Historically, Amtrak has not succeeded in protecting its passengers from serious and fatal injuries during derailments, especially overturn derailments. A review of historic records of fatal rail accidents, where passengers are killed or seriously injured when forcibly displaced and ejected from the train, indicates a safety risk to the riding public that has never been addressed and resolved.

The of these two fatal Amtrak accidents that resulted in passenger fatalities and serious injuries, in Philadelphia, PA and DuPont, WA, provide an example, or abbreviated case study, of a safety impasse. The impasse originated after a robust evidence-based accident investigation was performed by the NTSB. This abbreviated

[2] Specifics on passenger safety engineering designs are included in NTSB's accident investigation reports, listed in the Bibliography.

case study will look at two of the safety recommendations issued by the NTSB to the FRA following the Philadelphia accident investigation and the ensuing disagreement on the necessity of these two safety recommendations, as documented in official correspondence between the Chairman of the NTSB and the Administrator of the FRA. The FRA determined that it would not follow the NTSB's safety recommendations, resulting in the NTSB designating the safety recommendations as Closed—Unacceptable Action after the Philadelphia accident. The list, below, provides the types of classification status that are used by the NTSB, for safety recommendations that are open or closed.[3]

The possible classifications for NTSB's open safety recommendations are:

Open—Await Response

Open—Initial Response Received

Open—Acceptable Response

Open—Acceptable Alternate Response

Open—Unacceptable Response

The possible classifications for NTSB's closed safety recommendations are:

Closed—Acceptable Action

Closed—Acceptable Action/Superseded

Closed—Acceptable Alternate Action

[3] Examples of each type of safety recommendation classification can be found by searching NTSB rail accident investigations' safety recommendations on the NTSB website: https://www.ntsb.gov/safety/safety-recs/layouts/ntsb.recsearch/RecTabs.aspx.

Closed—Exceeds Recommended Action

Closed—Reconsidered

Closed—Superseded

Closed—Unacceptable Action

Closed—Unacceptable Action/No Response Received

Closed—Unacceptable Action/Superseded

Closed—No Longer Applicable

A timeline is laid out for the correspondence which continued after the second fatal passenger rail accident in DuPont, Washington. That accident investigation partly resulted in the reiteration of the two Philadelphia safety recommendations by the NTSB to the FRA. These two safety recommendations were again rejected by the FRA, continuing the safety impasse, which stands today.

A brief review of shortfalls in the FRA's human factors research that informs the factual basis for their rejection of the NTSB's two safety recommendations supports the conclusion that this safety impasse is not due to evidence-based factors. This leads to the following chapter, which poses a normative process, based on a moral framework for duty-based analysis.

Fatal accident, Philadelphia, Pennsylvania, May 12, 2015

Amtrak train 188 left Philadelphia's 30th Street Station, bound for New York City, the night of May 12, 2015. Eleven minutes later, the train entered a curve in the track,

traveling at 106 mph where the speed limit in the curve was 50 mph. The engineer applied emergency braking, slowing the train to 102 mph, however the train left the track at the curve, derailing at a high speed. An aerial view of the accident location, which includes derailed and overturned rail cars and the locomotive, is shown in Figure 1.

Figure 1. Ariel view of the 2015 Amtrak accident scene, north of Philadelphia, PA's 30th Street Station.[4]

[4] NTSB, *Derailment of Amtrak Passenger Train 188, Philadelphia, Pennsylvania, May 12, 2015*, RAR-16/02. (Washington, DC: NTSB, 2017), 1.

Of the 253 people on board the train, 193 people were injured, and eight people were fatally injured. Two of the fatally injured passengers were ejected through train windows. One was found under the third car and the other was found adjacent to the third car. Two other fatally injured passengers were partially ejected from their train car through the windows and trapped under a train car. Of the 193 injured passengers, 46 of them sustained serious injuries to the chest, neck, head, or spinal cord.[5]

The NTSB conducted an investigation of the accident. This process includes an on-scene investigation, determining factual findings, analysis, conclusions, and a determination of the probable cause of the accident and contributing factors. The investigation led to issuing safety recommendations to avoid similar accidents in the future. The NTSB's findings from the Philadelphia rail accident investigation included a determination that passengers were thrown from their seats and injured when the rail cars were derailed and overturned.

The NTSB's statement of probable cause of the accident was, "…the engineer's acceleration to 106 mph as he entered a curve with a 50 mph speed restriction, due to his loss of situational awareness likely because his attention was diverted to an emergency situation with another train."[6] A factor that contributed to the severity of the passengers'

[5] Ibid., 1.

[6] Ibid., 45.

injuries was inadequate FRA requirements for passenger protections, if a rail car derailed and overturned.

The NTSB issued several Safety Recommendations, aimed at preventing similar accidents in the future. Safety Recommendations are the NTSB's primary product for improving transportation safety both within a rail line, and across the national rail industry. Among the Safety Recommendations made by the NTSB were the following two Safety Recommendations to FRA:

> Conduct research to evaluate the causes of passenger injuries in passenger railcar derailments and overturns and evaluate potential methods for mitigating those injuries, such as installing seat belts in railcars and securing potential projectiles (Safety Recommendation number R-16-35).
>
> When the research specified in Safety Recommendation R-16-35 identifies safety improvements, use the findings to develop occupant protection standards for passenger railcars that will mitigate passenger injuries likely to occur during derailments and overturns (Safety Recommendation number R-16-36).[7]

Fatal accident, DuPont, Washington, December 18, 2017

Amtrak train 501 left Seattle's Holgate Street facility on December 18, 2017. It entered a curve in the track at overspeed, traveling 78 mph in a 30 mph speed restricted area. The train derailed on an elevated section of track that passed over a highway. When it left the track, the lead locomotive and several passenger cars fell off the elevated tracks, down an embankment, landing on the highway. Several vehicles on the highway were hit

[7] NTSB, *Amtrak Train 501 Derailment, DuPont, Washington, December 18, 2017*, RAR-19/01. (Washington, DC: NTSB, 2019), 128.

by the rail cars. An aerial view of the DuPont, WA Amtrak accident site, to include the derailed lead locomotive, several derailed and overturned passenger rail cars, and highway vehicles impacted by debris, is provided in Figure 2.

Figure 2. Ariel view of the 2017 Amtrak accident scene in DuPont, WA, showing the highway running diagonally and the lead locomotive resting in the upper left corner, on the highway.[8]

There were 82 people on board the train. Three passengers were killed, 57 passengers and train crew members were injured, and eight people who were in road

[8] Ibid., 5.

vehicles on the highway were injured. Two of the three fatally injured passengers were ejected from the rail car through a hole that was torn into the car's underside during the derailment and roll-over. Two of the injured passengers were partially ejected from the rail car through this hole in the underside.

The NTSB's investigation of this accident and the determination of probable cause and contributing factors included, "severe damage to railcar-body structures which then failed to provide occupant protection resulting in passenger ejections, injuries, and fatalities."[9] The NTSB also found that "Limited research has been conducted into the effectiveness of compartmentalization in passenger railcars for individuals that fall outside of the testing standard range, such as small children."[10] The NTSB reiterated Safety Recommendations R-16-35 and R-16-36, reclassifying them as "Open—Unacceptable Response."[11]

Timeline of Events Following the Accidents, Leading to the Safety Impasse

The following timeline provides the Amtrak accidents relevant to this example of a safety impasse and indicates the NTSB's actions and FRA's responses to the NTSB, based on official correspondence between the Chairman of the NTSB and the FRA

[9] Ibid., 11.

[10] Ibid., 123.

[11] Ibid., 124.

Administrator.

May 12, 2015, an Amtrak passenger train derailed on a curve at overspeed. The accident occurred in Philadelphia, Pennsylvania, resulting in eight passenger fatalities and 193 injured passengers.

May 17, 2016, the NTSB adopted its report on the accident and issued safety recommendations, including R-16-35 and R-16-36 that were issued to the FRA.

August 23, 2017, the FRA Acting Administrator responded to the NTSB Chairman that its ongoing efforts already responded to Safety Recommendations R-16-35 and R-16-36 and requested that the NTSB reclassify these two recommendations as "Closed-Acceptable Response". The letter further stated that the purpose of seatbelts and other methods of passenger protection is to give passengers the ability to survive a deceleration of the volume area that they occupy in the rail car, but without providing any scientific proof or references to support this statement, and without addressing passenger ejections from the train. The letter concluded by stating that the FRA does not plan to conduct comprehensive research into the causes of injuries to passengers during collisions and derailments but will continue to evaluate these causes as issues come up. The NTSB classified the FRA's response as "Closed—Unacceptable Response."

December 18, 2017, an Amtrak passenger train derailed on a curve at overspeed. The accident occurred in DuPont, Washington, resulting in three passenger fatalities, 57

people injured onboard the train, and eight people injured on the highway, in their vehicles.

February 4, 2018, an Amtrak accident occurred in Cayce, South Carolina where 90 of the 149 people onboard the train were injured and both crewmembers were fatally injured when the train derailed after impact and came to an upright standstill. The NTSB concluded that the primary cause of passenger injuries was being thrown from their seats.

June 24, 2019, the NTSB issued their report on the DuPont, Washington accident investigation and reiterated Safety Recommendations R-16-35 and R-16-36 as "Open—Unacceptable Response." The NTSB Chairman wrote to the FRA Administrator, stating, "The NTSB does not agree with the FRA that its current research program and regulations effectively address protecting passengers in railcars involved in derailments and overturns."[12] The letter continued, "In the span of 4 years, the NTSB has investigated three major railroad accidents involving passenger railcar derailments that resulted in significant lateral acceleration, for which containment did not adequately protect the 11 passengers killed after being ejected from the railcars. In addition, containment did not fully protect the over 300 passengers hospitalized in these accidents."[13]

July 23, 2019, the NTSB adopted its report on the Cayce, South Carolina accident and reiterated Safety Recommendations R-16-35 and R-16-36 to the FRA.

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[12] NTSB correspondence, last modified June 24, 2019, https://www.ntsb.gov/safety/safety-recs/layouts/ntsb.recsearch/RecTabs.aspx.

[13] Ibid, 1.

September 27, 2019, The FRA Administrator responded to the NTSB Chairman, regarding the DuPont, Washington accident. He stated that the FRA's position on Safety Recommendation R-16-35 had not changed, and that no action would be taken by the FRA on Safety Recommendations R-16-35 and R-16-36. The FRA requested, again, that the NTSB close the safety recommendations.

September 30, 2019, The NTSB Chairman wrote to the FRA Administrator, stating that the Cayce, South Carolina accident report was now published, that the passenger injuries in the Cayce accident again showed the need for better rail passenger protections, and that Safety Recommendations R-16-35 and R-16-36 were again reiterated.

January 23, 2020, The FRA Administrator responded to the NTSB Chairman stating that the FRA would not take any action on Safety Recommendations R-16-35 and R-16-36.

The Timeline focused on the two major accidents, first in Philadelphia, PA and later in DuPont, WA, that resulted in passenger fatalities and injuries following train derailments and rollovers at overspeed. A third accident at Caycee, SC was included as the two safety recommendations were reiterated for this accident. It also provides further evidence supporting the need for the safety regulations to improve passenger safety. All three accidents are included in the safety impasse between the FRA and the NTSB.

The previous sections also detailed the FRA's responses to the NTSB's safety recommendations, repeatedly stating that the FRA has conducted research that supports the efficacy of their current regulations on protecting passengers from injury and death from a rail accident. The next section provides examples of flaws in that research methodology, giving pause to the credibility of the epistemic, scientific basis for the FRA's declining to follow the NTSB's safety recommendations for improving passenger protection. It then addresses the question of what leads to an impasse, if it is not based on a scientific foundation?

Human Factors Review of the FRA's Passenger Protection Research

A review of the human factors research methodology of the FRA's rail passenger protection research published in 2002, 2003, and 2009 determined that although it is conducted with full-scale collision testing, the research methodologies were flawed, rendering the results not relevant to mitigating the actual factors that occurred during these two fatal derailment and rollover at overspeed accidents.[14] These flaws are:

[14] FRA, *Passenger Rail Two-Car Impact Test, Volume I: Summary of Occupant Protection Program.* DOT/FRA/ORD-01/22.II. (Washington, DC: US Department of Transportation, 2002); FRA, *Passenger Rail Train-to-Train Impact Test Volume II: Summary of Occupant Protection Program.* DOT/FRA/ORD-03/17.II. (Washington, DC: US Department of Transportation, 2003); FRA, *Occupant Protection Experiments in Support of a Full-Scale Train-to-Train Crash Energy Management Equipment Collision Test*, DOT/FRA/ORD-09/14. (Washington, DC: US Department of Transportation, 2009).

1) regarding testing scenarios: the FRA methodology focused on in-line rail collisions, where a moving train hits a stationary train, and did not test train derailments with passenger car rollovers.

2) regarding testing speeds: the testing was conducted at speeds of less than 36 mph, and not at the high speeds that occurred in these two example derailments with rollover accidents and other accidents with serious passenger injuries. The two accident speeds were 102 mph in a speed limit of 50 mph and 78 mph in a speed limit of 30 mph.

3) regarding anthropomorphic testing: the testing monitored passenger anthropomorphic test devices (crash dummies) for ergonomic responses to the initial impact of an accident scenario for in-line rail collisions. They did not monitor responses to secondary or tertiary impacts of derailment and rollover events which occurred in these two accidents described in Chapter One, and in other accidents with serious passenger injuries. In addition, not all crash dummies were wired with instruments to detect ergonomic responses to the test accident, so injury loads were not captured.

Figure 3 provides an example of this. It shows the side view of the post-test landing position of a 95th percentile male crash dummy, which was positioned before the test in a window seat and not seat-belted. The post-test photo shows a red arrow pointed toward the head, which is not visible as it is wedged between the front-row seat and the train car wall.[15] In describing the post-test landing position of the crash dummy, the FRA

[15] The red arrows in Figures 3, 4, and 5 were added to the photographs to assist in the descriptions.

report states it was, “stuck in its seat, with its head wedged between the front-row seats and the wall. Emergency egress for an occupant in this situation would likely not have been possible.”[16]

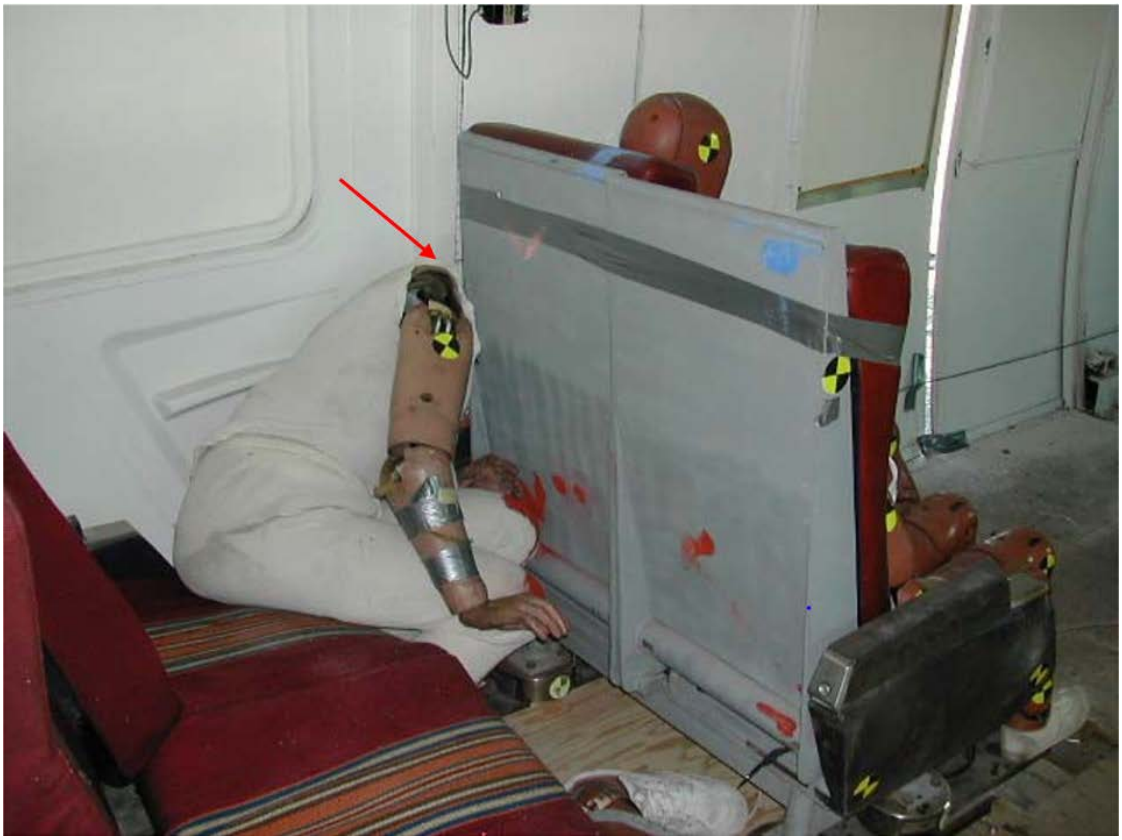

Figure 3. Post-test side view of 95th percentile male crash dummy, in the window seat and not seat-belted, with head wedged between seatback and train car wall.[17]

[16] Ibid, 58.

[17] FRA, *Passenger Rail Train-to-Train Impact Test Volume II: Summary of Occupant Protection Program*, 45.

The crash dummy's motion during the test was captured on a video recording. First, the crash dummy's head impacted the seat back, then the head and chin were pushed over the seat back. Next the crash dummy retracted back and then rebounded toward the space between the front-row seat and the train car wall where the head became wedged. This crash dummy was not instrumented for monitoring for ergonomic responses, so the extent of injury loads was unmeasured and therefore is unknown. Figure 4 provides a front angled view of the crash dummy's head, indicated by the red arrow on the right.[18]

Figure 4. Post-test front angled view of landing positions of two unrestrained crash dummies (see red arrows) and two restrained crash dummies.[19]

[18] Ibid, 44.
[19] Ibid., 44.

A second crash dummy, also not seat-belted, was seated by the aisle. Its landing position on the aisle floor is indicated by the red arrow on the left in Figure 4. The aisle-side crash dummy's motion during the test started with its head impacting the seat back in front of it. The body rose vertically, with its head still "planted' against the seat back. The knees then hit the seat back and the head rebounded off, then hit the seat back again. The crash dummy then rebounded off the seat back and landed head-first on the aisle floor. Of note are the third and forth crash dummies in Figure 4. They were seat belted in the two aft seats and remained in their seats throughout the test, although they leaned forward in response to the test's lateral forces.

Figure 5 provides a close-up view of the crash dummy's head wedged between the seat back of the aft seat and the rail car wall.[20] In this photo, the crash dummy's head appears to be fully forward of the seat back, having passed through the gap between the seat back and the rail car wall. The extent of the similarities or differences between the configuration of these test seats and the configurations of the Amtrak seats in the Philadelphia and DuPont accidents was not stated by the FRA in their correspondence with the NTSB. However, if the configurations are identical, then this scenario was not measured and therefore not accounted for. And, if the configurations are dissimilar, then this scenario was not addressed and is therefore the impact is unknown.

[20] Ibid., 45.

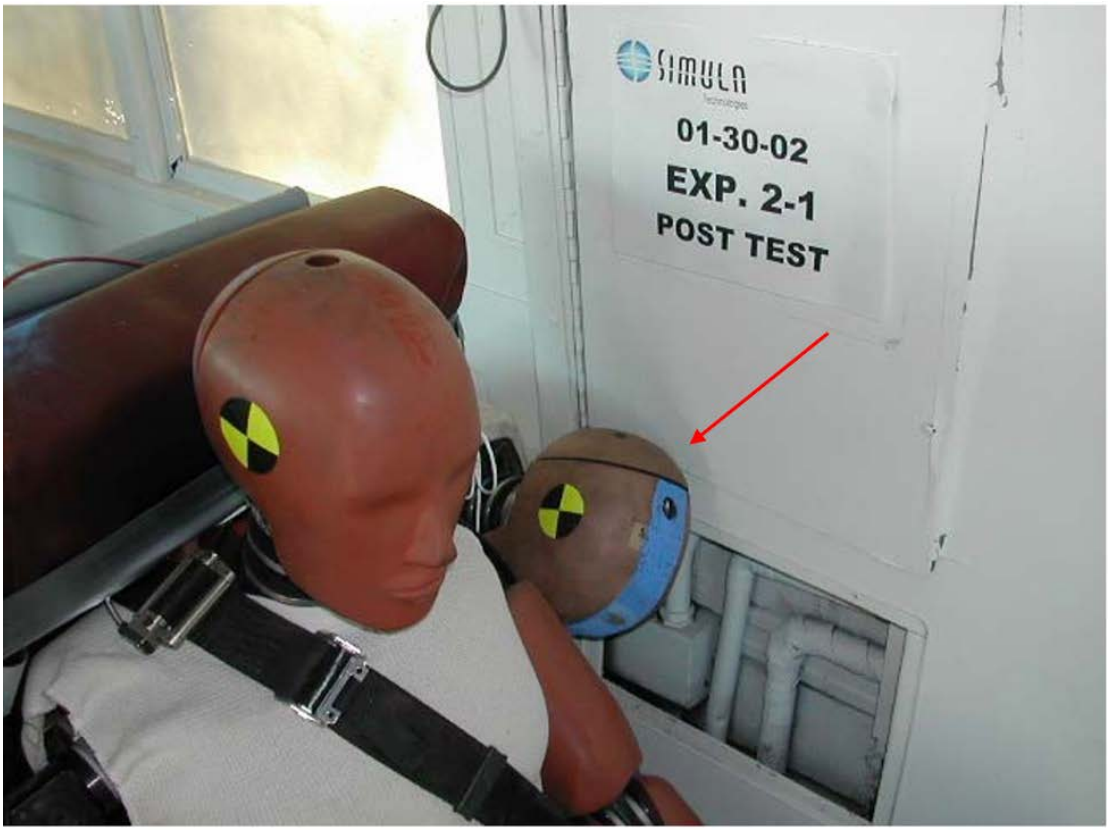

Figure 5. Close-up view of the head of an unrestrained crash dummy, wedged between the forward seat back and the train car wall (see red arrow).[21]

4) regarding representation of the crash dummies to the US population: the FRA research used crash dummies to represent the 5th percentile of females and the 50th and 95th percentile of males and to determine the extent of injuries that occurred during the testing scenarios.[22] The FRA testing did not use devices to represent people who are

[21] Ibid., 45.

[22] FRA, *Passenger Rail Train-to-Train Impact Test Volume II: Summary of Occupant Protection Program;* Tyrell, David, Zolock, John, and Vaningen-Dunn, Caroline, 2002. "Train-to-Train

taller than 6'1" or heavier than 222 lbs. (that is, above the 95th percentile of males), or shorter than 5' or lighter than 110 lbs. (that is, below the 5th percentile of females), including infants or small children, therefore the research conclusions are not relevant to mitigating harm to a significant percentage of rail passengers.

The question here is, why would a government agency continue to state reliance on research results to support its position in opposition to another government agency's safety recommendations, if that research is not targeted at either the conditions under which accidents with severe passenger injuries and fatalities occur, nor including all types of passengers, based on their physical characteristics? Why perpetuate an impasse when the epistemic foundation for it can be dismissed?

What Leads to a Safety Impasse?

Setting aside decision-making motivated by political and industry considerations, a possible explanation is that the FRA responses to the NTSB stem from the type of agency that it is, and the particular lens through which it views safety issues. This is in contrast to the type of agency that the NTSB is, and the lens through which it views safety issues. Each agency's mission statement is a viable clue or starting place to determine what lens it uses. Parsing the mission statements may provide some insight into what lens each agency uses.

Impact Test: Occupant Protection Experiments," Paper presented at the 2002 ASME International Mechanical Engineering Congress & Exposition, New Orleans, LA, November 17-22, 2002.

The FRA's mission is to "enable the safe, reliable, and efficient movement of people and goods for a strong America, now and in the future."[23] The FRA is responsible for promulgating and enforcing safety regulations on passenger and freight rail transportation. The underlying assumption is, if a railroad follows the regulations, then it will operate safely, and provide that people (passengers, employees, and the public writ large) will be safe from harm due to rail accidents.

In contrast, the NTSB's mission is, "Making transportation safer by conducting independent accident investigations, advocating safety improvements, and deciding and mariners' certification appeals."[24] The NTSB does not approach an accident investigation by solely looking at what regulations were broken to determine the probable cause. A probable underlying assumption is that people make mistakes, and rules get broken, and allowing that, railroads still need to operate safely, so people (passengers, employees and the public writ large) will be safe from harm due to rail accidents.

The FRA's mission statement appears to place equal importance on the goals of safety, reliability, and efficiency. Although safety is mentioned first, there need not be an assumption of prioritization within the list, and the FRA does not offer any statement of prioritization. The FRA's mission statement is formatted as: Do X, to accomplish Y,

[23] FRA. n.d. "Program Offices Overview." About FRA. Accessed March 7, 2020. https://railroads.dot.gov/about-fra/program-offices/program-offices-overview.

[24] NTSB. n.d. "About the NTSB." NTSB. Accessed March 7, 2020. https://www.ntsb.gov/about/Pages/default.aspx.

where X is enabling safe, reliable, and efficient movement of people and goods, and Y is for a strong America, now and in the future.

The NTSB's mission statement begins with the goal, "making transportation safer," and follows it with methods to accomplish that. Safety, then, is the one and only goal. The mission statement is formatted as: Doing X. It then gives examples of X. Here, doing X is making transportation safer, and examples of X are conducting independent accident investigations, advocating safety improvements, and deciding pilots' and mariners' certification appeals.

Parsing the mission statement may appear too abstract or too subjective; it is a starting point for answering the question: What leads to an impasse, if it is not based on a comprehensive epistemic, evidence-based foundation? The answer is a non-epistemic, duty-based foundation. The differences between the two mission statements will be useful later in the next two chapters, which explore the application of a normative duty-based analysis to the problem of a safety impasse.

CHAPTER TWO

A MORAL FRAMEWORK FOR INDENTIFYING FACTORS THAT LEAD TO AN IMPASSE

The previous chapter discussed the safety impasse between the NTSB and the FRA regarding two passenger protection safety recommendations. This impasse was demonstrated in the official correspondence between the Chairman of the NTSB and the Administrator of the FRA regarding two fatal Amtrak accidents and two of the safety recommendations issued by the NTSB as a means to prevent future harm to passengers, employees and the general public. This safety impasse still exists today and may appear to be based on incommensurate differences in evidence-based safety conclusions between the two agencies whose missions and goals do not align.

This chapter uses a systems approach to offer a different method for viewing this safety impasse by providing the foundation for a duty-based approach in lieu of an evidence-based approach. This systems approach considers organizations such as the NTSB, the FRA, and Amtrak as integral subsystems responsible for establishing, monitoring, and maintaining the safety of the national passenger rail system. The systems approach considers all functional components or subsystems together in their role of providing a service, such as passenger transportation, as opposed to focusing on the subsystems alone and in isolation of one another. The systems approach provides a unique perspective for examining joint organizational patterns and synergies, as well as their

tendency to seek equilibrium and resist new ideas; to resist change.[1] Here, the role of moral argument is to influence organizational change, specifically when the foundational ethics of organizations conflict and the resulting decisions and actions reach an impasse and appear incommensurate.

First, a moral process framework is offered for duty-based decision-making. Next, this framework is used to work through an example that illustrates points where the two agencies align, where they appear to diverge within the moral framework, and where failure points in the moral process framework can be identified. This provides a path to discern factors that led to the safety impasse.

The Moral Process Framework

A schema for the moral process by which decision-making that leads to a safety impasse is presented as a framework. The framework is not a method to determine universal moral truths, rather it illustrates how actions are grounded in moral reasoning that is founded on principles and values that, in turn, are based on a worldview. Within this framework, judgments and decisions illustrate moral reasoning, and a worldview is developed, over time, based on cultural norms and normative ethics. The latter, normative ethics, will be discussed in Chapter Three.

[1] Thomas Kuhn, *The Structure of Scientific Revolutions*. (Chicago: University of Chicago Press, 2012).

Figure 6 illustrates the Moral Process Framework as having six stages or steps.[2] The steps start with overarching worldviews and continue through to specific actions. For one worldview, there are multiple values, and for every value there can be multiple related principles, continuing onward through judgments, decisions, and actions.

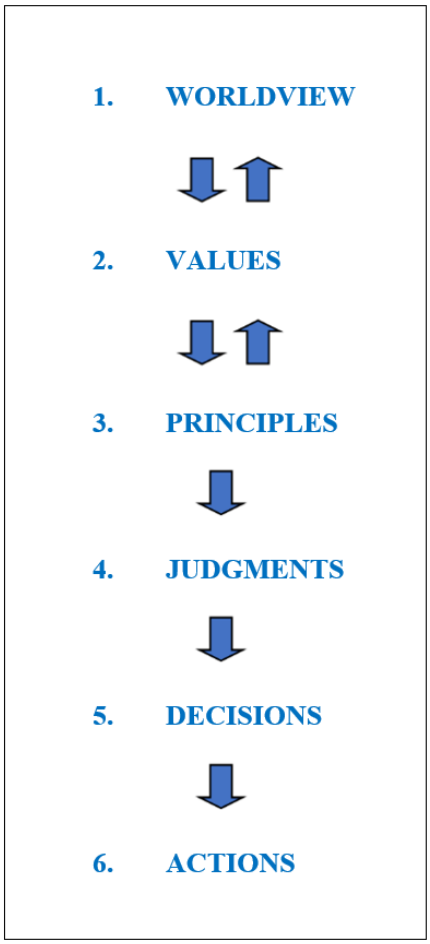

Figure 6. The Moral Process Framework.

[2] Adapted from Pojman, Louis, *Ethics: Discovering Right and Wrong*. (Albany, NY: Thomas Wadsworth Publishing, 2006) 88.

Within the Moral Process Framework, values are viewed in a broad sense, where the opposite of values are facts, which are the foundation for empirical science.[3] The values that are important to a person are based on their cultural norms and normative ethics and are the foundation for actions based on moral decision-making (which encompasses the steps of judgments and decisions). Values are important to all types of Agents, from an individual to a corporation or a federal agency. For a large organization, however, the arrows represent complex communications and deliberation processes. The values and principles of an organization are promulgated through many methods, to include mission statements, goals, and strategic plans that can be linked to employee performance.

The arrows in the Moral Process Framework indicate the direction of influence. These arrows could be placed in both directions for all six steps in the process, however, for this framework they go in both directions only between worldview and values and between values and principles in order to emphasize the areas that may best influence the formation and outcome of a safety impasse.

The two-way arrows indicate characteristics of values and principles; they need not be absolute. They are considered the correct moral guidance for actions, until proven otherwise. This occurs when two principles are being applied, but they contradict each

[3] The broad sense is opposed to values in a narrow sense, where value is good, and the opposite is bad or not of value.

other or appear to dispute each other. When this happens, a judgment must be made, to determine which principle takes precedence over the other. And so, although values and principles direct the decision-making process that determines our actions, they are considered prima facie, meaning they are accepted as correct until determined otherwise. This characteristic of being overridable, non-absolute, or relative to a situation, is important when two principles contradict each other, causing an impasse.

Principles are developed from and influenced by our values. They clarify our values and guide our judgments and actions. For example, the value "life" has many principles derived from it. Two of these principles are "protect life" and "do not kill". There can be a moral situation where these two principles are in conflict. For example, when a person is violently attacked and must decide to either protect themselves, to the point of killing the attacker in self-defense, or to adhere to the principle, "do not kill," and then be killed by the attacker. Should they not protect their own life in order in order to live?

Here, the person is faced with two principles that prescribe conflicting actions. By following the steps in the Moral Process Framework, when faced with conflicting principles, a judgement is made as to which is the determining principle to follow. This defines the person's duty; the morally correct act.[4] However, knowing one's duty and performing one's duty are two different things. So, the next step in the process is to make

[4] Pojman, *Ethics: Discovering Right and Wrong,* 88.

the decision of what is the morally correct act, and the final step is to take that action and do the morally correct thing.

That is the ideal Moral Process. People, however, are fallible. There are two places in this process where, even when the judgement is made as to which is the determining moral principle, the person or organization (Agent) fails to follow through to action. The first failure point is when the correct decision is not made, even when it is judged to be correct. This is a *perverse will*. The second failure point is when the determining action is not made, even when it was correctly decided what the action should be. This is a *weakness of the will*; a weakness in not doing the right thing even when it is known and decided what the right thing is. This characteristic of Agency will be further developed in Chapter Three, within a broader discussion of one aspect of duty-based analysis, the Harm Assessment.

The next section will look at how the Moral Process Framework can be applied in an example in which two Agents (organizations), the NTSB and the FRA, have similarities and differences. These differences form the basis for a duty-based safety impasse which is a form of moral impasse.

An Example of a Moral Impasse Within the Moral Process Framework

The previous section discussed how principles are derived from our values and guide our judgments and actions. One example of the relationship between a value and two related principles was provided: that is, from the value of "life" the principles,

"protect life" and "do not kill" are derived. Here are additional examples of values related to principles:

From the value of "safety" the principle of non-maleficence, or "do no harm" is derived.

From the value of "reliability" the principles of "be trustworthy" and "perform consistently" are derived.

From the value of "efficiency" the principles of "do not waste time" and "do not waste money" are derived.

These values of safety, reliability and efficiency are taken from the mission statements of the FRA and the NTSB, as stated in Chapter One. The FRA's mission is to "enable the safe, reliable, and efficient movement of people and goods for a strong America, now and in the future."[5] The NTSB's mission is, "Making transportation safer by conducting independent accident investigations, advocating safety improvements, and deciding pilots' and mariners' certification appeals."[6]

The NTSB's value of "safety" and the derived principle of non-maleficence, or "do no harm," is straightforward. The FRA's values of "safety," "reliability," and

[5] FRA. n.d. "Program Offices Overview." About FRA. Accessed March 7, 2020. https://railroads.dot.gov/about-fra/program-offices/program-offices-overview.

[6] NTSB. n.d. "About the NTSB." NTSB. Accessed March 7, 2020. https://www.ntsb.gov/about/Pages/default.aspx.

"efficiency," and the derived principles are not as straightforward. The derived principles, as stated above, are:

Do no harm.

Be trustworthy.

Perform consistently.

Do not waste time.

Do not waste money.

The NTSB and the FRA are in alignment on the value of "safety," and in alignment with the derived principle of "do no harm." However, the other values in the FRA mission statement, "reliability" and "efficiency," indicate possible areas of divergence when applied to concrete situations.

To illustrate this, within the Moral Process Framework, the values, principles, judgments, decisions and actions that flow from the FRA's mission statement will be reviewed in light of the problem of the safety impasse described in Chapter One, to explore possible reasons for the impasse.

The two safety recommendations from Chapter One, that the NTSB made to the FRA, and that the FRA rejected, leading to the safety impasse are:

> Conduct research to evaluate the causes of passenger injuries in passenger railcar derailments and overturns and evaluate potential methods for mitigating those injuries, such as installing seat belts in railcars and securing potential projectiles (Safety Recommendation number R-16-35).

When the research specified in Safety Recommendation R-16-35

> identifies safety improvements, use the findings to develop occupant protection standards for passenger railcars that will mitigate passenger injuries likely to occur during derailments and overturns (Safety Recommendation number R-16-36).[7]

Based on its mission statement, the FRA values safety, reliability, and efficiency, and the enabling of these values in the passenger rail system. The FRA has conducted several human factors research studies focused on improving passenger safety. However, as discussed in Chapter One, the research was performed with four methodological flaws that rendered the results not relevant to mitigating the safety risk factors that occurred during the two fatal derailments and rollovers at overspeed accidents. Thus, the FRA's research is determined to contradict the values and principles derived from the FRA's mission statement. It was wasteful of time and money. It also decreased the trustworthiness for overseeing reliable passenger rail service and decreased the safety of the passenger rail system, as evidenced by the two fatal accidents that occurred during the more than two and a half years between the fatal accident in Philadelphia, PA and the fatal accident in Cayce, SC.

By referring to the Moral Process Framework, the question arises, was this a failure in making the correct decision during step 5 (to conduct viable human factors safety research), meaning was it a perverse will? Or, was this a failure to do the right act at step 6 (conducting viable research), meaning was it a weakness of the will?

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[7] NTSB, *Amtrak Train 501 Derailment, DuPont, Washington, December 18, 2017*, 128.

This analysis of failure points in the Moral Process Framework can be useful to an organization as part of an after-action review following an accident, the ensuing investigation, and receiving safety recommendations from the NTSB. It can be brought down to the level of the decision-making team or individuals as part of a systems approach to safety improvement. This can occur without looking to cast blame for problems related to Agency, that is, a failure to act in carrying out a decision (weakness of the will) or for a failure to make the decision to act (problem of the will). In this way, it can be useful as a beginning point for resolving a Moral Impasse that is in the form of a safety impasse between two agencies.

The next chapter will build on aspects of the Moral Process Framework by looking at two areas of normative ethics, the teleological and the deontological, as examples of the first stage, "Worldview." It will examine how they relate to the missions of the FRA and the NTSB, the distinct lenses through which these agencies approach rail passenger safety, and considerations of how this might provide insight into the safety impasse, as factors of a Normative Assessment. Chapter Three will also continue to explore the concepts of Agency and Principles, developed in this chapter, as factors of a Harm Assessment. It concludes with the formation of the Kantian Safety Imperative, which is posited as a means to move toward a resolution of the safety impasse.

Chapter Three begins by mapping duty-based factors in an Ishikawa diagram. These factors fall into four categories of assessments, a Harm Assessment, a Normative

Assessment, a Corporate Assessment and a Public Safety Assessment. The Ishikawa diagram provides both a visual representation of factors leading to the safety impasse and also offers an approach to strategically address safety issues from a broader perspective and across the population over time. The strategic approach to address safety issues is based on a Corporate Assessment and a Public Safety Assessment, which will be developed in the final chapter.

CHAPTER THREE

TOWARD A DUTY-BASED ANALYSIS OF PASSENGER SAFETY

The focus of this chapter is to examine the elements for developing a duty-based analysis that describes the points of failure leading to the safety impasse discussed previously. The duty-based analysis highlights a novel approach toward understanding the safety impasse and, perhaps, its future resolution leading to improved passenger rail safety.

The duty-based analysis is organized into four areas: Harm Assessment, Normative Assessment, Corporate Assessment, and Public Safety Assessment. This chapter describes the first two areas, the Harm Assessment and the Normative Assessment, and analyzes factors that may contribute to a safety impasse between two Agents, such as the NTSB and the FRA. The Harm Assessment applies two concepts from Chapter Two: Agency, which includes problems of the Will, and the Principle of Do No Harm or Non-Maleficence, which is based on the Moral Process Framework. The Normative Assessment applies two normative ethical theories, Deontology and Teleology, to the problem of a safety impasse. The next chapter introduces a broader definition of a safety impasse within the society and offers a Corporate Assessment and a Public Safety Assessment as strategic methods to address possible safety impasses on that larger level.

The duty-based analysis of the safety impasse is visualized using an Ishikawa Diagram (also called a Fishbone Diagram). This provides a graphical representation of the four areas of assessment and their interrelationships (see Figure 7).

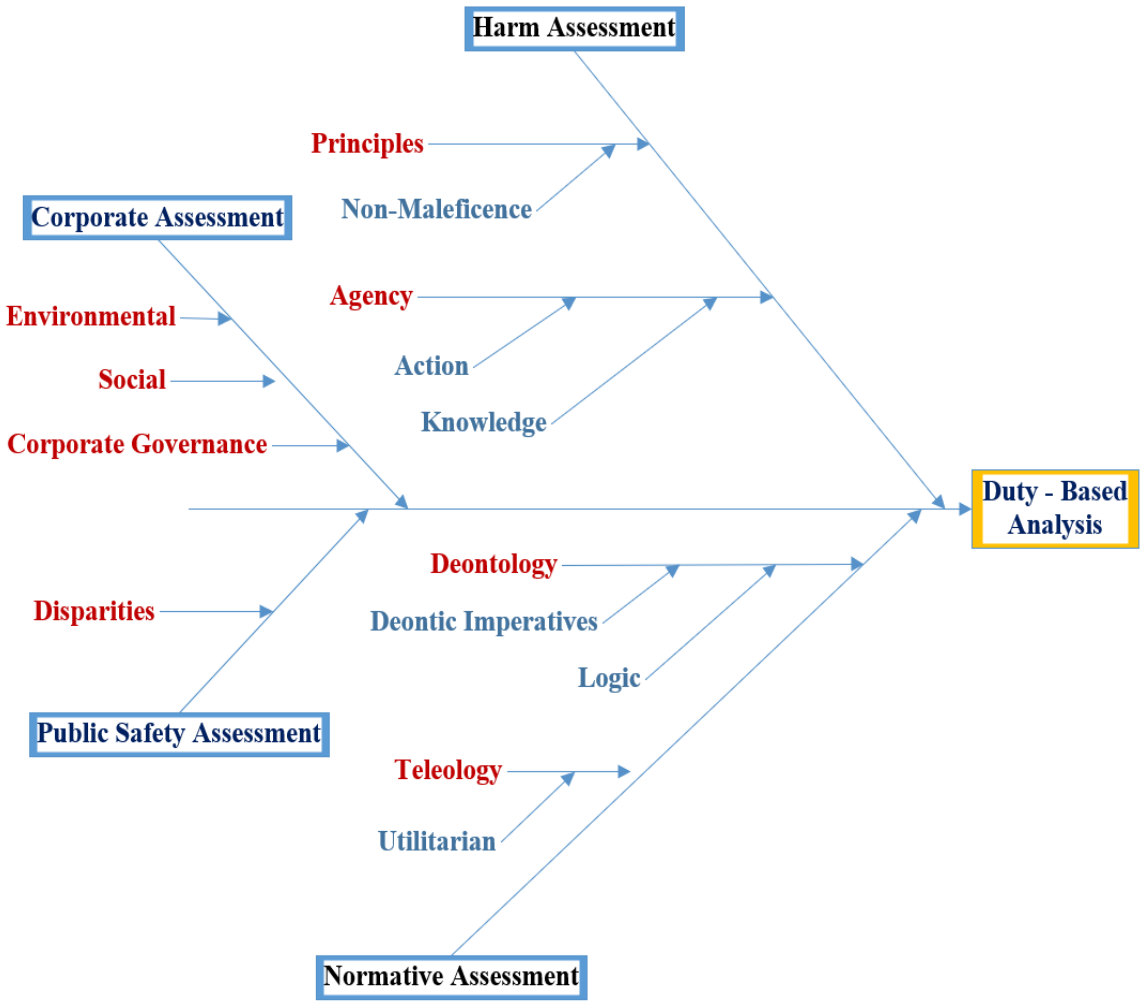

Figure 7. An Ishika Diagram representing potential factors of a safety impasse that may be included in a duty-based analysis.

The Ishikawa Diagram is often used to find and analyze root causes to difficult problems and to brainstorm and organize contributing factors and their relationships. It is used in Figure 7 to identify and organize the analysis factors deemed to contribute to a safety impasse and likely to be useful in developing a method or formalism for duty-based analyses in the passenger rail industry.

Harm Assessment

The Harm Assessment is a series of questions formulated to determine intention and extent of harm, as it occurred in accidents that followed the creation of a safety impasse. An underlying assumption is that if a safety recommendation had been followed when first received, the later accidents and ensuing harm (injuries and fatalities) likely would have been avoided. It is not required for the Harm Assessment to prove that the harm would have been avoided; rather it is sufficient to establish the existence of safety recommendations aimed preemptively at preventing similar accidents in the future. The NTSB's congressional mandate to investigate accidents and develop safety recommendations to prevent accident reoccurrences, in part, meets the underlying assumption.

The Harm Assessment differs from safety risk assessments and risk mitigation strategies traditionally used in the discipline of safety science. A risk assessment is conducted to predict the likelihood of occurrence and degree of severity due to a safety risk; that is, a quantitative view of potential future harm. However, once an accident has

occurred, the actual harm is known for a particular set of events. Thus, the risk assessment is no longer useful, unless the safety professional wants to assess its inherent accuracies and failures or wants to extend its scope for future hazard scenarios. The Harm Assessment, on the other hand, provides a structure to examine the accident from a retrospective point of view.

Likewise, the safety mitigation strategy discussed in the safety impasse revealed that the Agent (the FRA) had evidence-based knowledge, following the first fatal accident, that a train traveling on a curve at overspeed will derail and overturn, and cause fatal harm to passengers. It also had evidence-based knowledge that all the risk mitigations in place, as discussed in Chapter One, were not sufficient to prevent fatal harm to passengers. And, after receipt of safety recommendations to keep similar accidents from happening in the future, the FRA judged them unnecessary, decided to not act upon them, beyond sending the letter to the NTSB. The Harm Assessment, on the other hand, extends the analysis of factual evidence to the realm of identifying the responsibilities to manage and mitigate safety hazards and thereby, reducing or eliminating risks.

Assessing harm, from a duty-based perspective, within the context of the passenger rail safety impasse, has two steps: determining what happened and determining why it happened. The duty-based approach differs from the empirical approach, which examines principally the physics- and science-based aspects of the accident; a train

derailing and overturning at overspeed. That is the domain of the NTSB's accident investigation process, which leads to safety recommendations and, in the example provided in Chapter One, a safety impasse.

The Harm Assessment examines two aspects of the safety impasse. First are Principles, as discussed in Chapter Two within the Moral Process Framework. Next is Agency which includes characteristics of who was harmed, who harmed them, what were the actions, and with what knowledge of possible harm.

The Harm Assessment is founded on the principle of Non-Maleficence. Applying Non-Maleficence to the problem of rail safety uses a process similar to that in the scientific and medical fields. Specifically, the Belmont Report, from the post-World War II National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, first articulated the ethical theory of Principlism. This was later developed into a framework of four moral principles for biomedical ethics that was derived from the common morality.[1]

These four principles are:

1) Respect for autonomy (a person's right to make their own decisions, based on their own values, and their right to act on these values)

2) Non-Maleficence (to not inflict intentional harm)

[1] Beauchamp, T. L., and Childress, J. F., *Principles of Biomedical Ethics*, (New York: Oxford University Press, 2009), 13.

3) Beneficence (to do good towards others, to act for the benefit of others; including minimal duty to do good through supererogatory acts)

4) Justice (equal treatment and fair distribution of benefits and burdens).

All four moral principles can be adapted from the biomedical application to address passenger rail safety; however, the principle of Non-maleficence is the focus for this example.

What is meant by Non-Maleficence? It is to do no harm, but what is meant by harm? This question does not concern the physical aspects of injuries and fatalities. Here, we address a continuum of harm to the wellness of civil people. This is defined by harm as actions regarding the infliction of harm.[2]

This leads to Harm Assessment questions based on Agency:

Who imposes harm and who receives harm (victim)?

Who benefits from the risk of harm? The one imposing the risk of harm (agent), or the one that risk of harm is imposed upon (victim)?

Harm Assessment questions regarding the victim of harm (the victims of the rail accidents) focus on knowledge, as seen in the following set of questions.

Was the victim a passenger, who purchased a ticket (a type of contract with the railroad for safe transportation from point A to point B), who boarded the train?

[2] Adapted from Pojman Louis, *Ethical Theory: Classical and Contemporary Readings* (Albany, NY: Wadsworth/Cengage Learning, 2011) 9-10.

Was the victim a bystander or non-participant (such as the people in their highway vehicles who were injured by the falling rail cars in DuPont, WA)?

Did the victim know the risk of harm?

Did the victim accept the risk of harm for themselves, or for another? Was this for a person with diminished or unformed Autonomy, such as a child?

Harm Assessment questions regarding the person or organization that was the Agent of harm to the victims (for example, the railroad or in this case, the FRA) address the type and level of harm. This is seen through the following set of questions.

Was the Agent aware of the risk of harm?

Was the harm unintended?

Was harm foreseen?

Was harm foreseeable?

Was harm allowed?

Was there a failure to stop harm?

Was harm preventable?

Did the Agent act to prevent harm?

Did the Agent fail to act to prevent harm?

Lastly, the Harm Assessment includes questions about the moral permissibility of actions**.** The assessment of an Agent's actions that result in harm is viewed two ways for the purpose of this example. Actions can be assessed as a matter of an agent's will, which

was discussed in Chapter Two. The actions can also be assessed as to their moral permissibility within a logic-based analysis, which is discussed next.

Moral permissibility is broken down into five normative statuses of actions. These are: permissible, obligatory, optional, impermissible and omissible. The propositions are mutually exclusive classifications of actions, and are jointly exhaustive of all classifications of actions. These are represented in Figure 8, which demonstrates that an action that is permissible can be obligatory or optional, but not both.[3] Omissible is a term for the opposite of permissible, but rarely used outside of a logic system. Here, it represents actions that are either optional or impermissible, but not both.

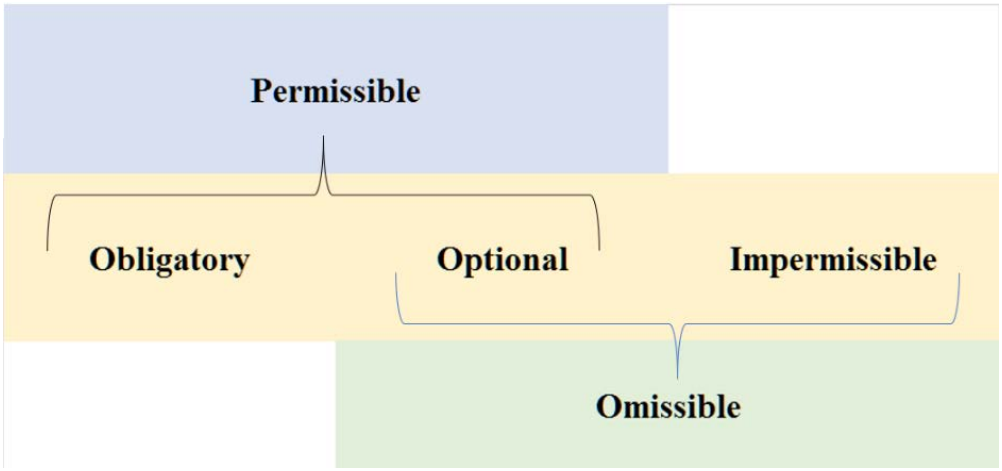

Figure 8. The logic-based threefold classification of propositions, to guage actions.[4]

[3] Adapted from McNamara, Paul. 2010 "Deontic Logic." The Stanford Encyclopedia of Philosophy, Stanford University, April 21, 2010. https://plato.stanford.edu/entries/logic-deontic/.

[4] Ibid., 1.

In summary, a Harm Assessment is a temporal extension of the usual safety/risk assessments. It is founded on the principle of Non-Maleficence and provides a retrospective look at factors that contributed to a safety impasse. The Agency portion of a Harm Assessment examines the factors of knowledge, action, and the moral permissibility of an action. This is beneficial in determining if the causal factors for a safety impasse arise from an Agent's actions/inactions that are problems of the Will (within the lower levels of the Moral Process), or are morally impermissible. The Harm Assessment is also beneficial in that it is likely to reveal additional dimensions for safety recommendations, as well as additional recipients. Most importantly, answers to the Harm Assessment are not likely obtained by investigators through singular interview; instead, repetative interviews likely will be needed to focus the subjective narrative evidence on particular points of interest. Through theses efforts, a new dimension of insight on the casualty, and the responsibility for the causality, of the accident are likely to be revealed, at least in a normative manner.

Normative Assessment

The next area of assessment in the duty-based analysis examines the safety impasse from the highest level of the Moral Process by looking at differences in worldviews. Two people or organizations can hold the same values and principles but approach them through different lenses, or worldviews.

Using our continued example of the safety impasse, the NTSB and the FRA both hold the value, "safety" and the corresponding principle, "do no harm." There are differences, however, in carrying out the principle of "do no harm," each with differing underlying reasons and influences. These were previously discussed as failures during the Moral Process involving problems of the Will; either a perverse will or a weak will (of an individual or an organization). These failures of the Will can explain why the FRA's human factors research was conducted with flawed methodologies. Other causal factors, such as political environments, are relevant here but are beyond the scope of this thesis.

This leads to the next level of ethical analysis, regarding normative ethical theories. The two types of normative ethics that are examined for this assessment are teleological (from the Greek word for goal) and deontological (from the Greek work for duty). Teleology focuses on consequences, foreseeable or not foreseeable, in looking to the goal or end result of action.[5]

The teleological theory of Utilitarianism deals with moral decision-making – deciding right from wrong.[6] Utilitarianism views moral obligations of an action in terms of its effect on the greatest happiness of the most people. Utilitarianism is seen as using

[5] Pojman, *Ethical Theory: Classical and Contemporary Readings*, 9-10.

[6] Mill, John Stewart, *Utilitarianism*, (Indianapolis: Bobbs-Merrill, 1957); Bentham, Jeremy, *An Introduction to the Principles of Morals and Legislation*, (Birmingham, AL: Legal Classics Library, 1986).

others as a means to one's own purposes or ends. It is results-based. An example of a Utilitarian organization is one that provides a service, such as passenger transportation, in exchange for a fee. In this way, Amtrak is viewed as a Utilitarian organization, as they can be seen as having passengers as a means to an end. This offers an answer to the unasked question; Why doesn't Amtrak follow the two NTSB safety recommendations on their own, at their own expense, without regulatory requirements from the FRA? If Amtrak were instead a Deontological organization, as most government agencies are, perhaps they would have performed in keeping with the two safety recommendations on their own initiative. As a Utilitarian organization, to do so would be considered a supererogatory action, beyond the call of duty, which typically is not approved by an organization's governing body. The Chapter Four provides thoughts for future work that might make this possible.

The second type of normative ethics is Deontology, based on duty or obligations. Deontology focuses on actions as morally right or wrong in themselves, and as the basis for duty.[7] Moral rules apply regardless of the consequences, which can provide a level of protection for an individual. The supreme principle of morality is seen as the autonomy of the Will, which is predicated on Freedom.

[7] Pojman, *Ethical Theory: Classical and Contemporary Readings*, 12.

Immanuel Kant is a founder of Deontology. He proposed that perfect duties are duties that we are always obligated to follow.[8] In this regard, the most perfect duty is to protect the life of each individual. Derived from this is the duty to not cause injury to other individuals, through action or through inaction. The application of this ethical theory to society then affirms that it is society's duty to protect the lives of individuals.

Perfect duties are Imperatives and Kant parsed out two types of Imperatives. One is hypothetical or conditional and takes the form, if you want X outcome, do Y action. In this way, hypothetical Imperatives are viewed as rule-based.

The other type of Imperative is categorical, which is not conditional. There is always an obligation to follow categorical Imperatives. They take the form, "Do X!". Categorical Imperatives are considered universal (applying to all, at all times) and not subjective.

Referring back to Chapter One, the parsing of the mission statements showed that the FRA's mission statement, formulated as "Do X, to accomplish Y", reflects the same format as the conditional Imperative, "If you want X outcome, do Y action". This is a rules-based formula, and that is consistent with the FRA's work to promulgate and enforce regulations (rules).

The NTSB's mission statement takes the form of, "Doing X", which is the same format as the Categorical Imperative, "Do X!". It is not conditioned on following rules

[8] Kant, *Foundations of the Metaphysics of Morals*, 33.

(Y), in order to accomplish X. This is consistent with the NTSB's focus, to be safe. There are various methods to accomplish safety, but the one goal is to be safe. This is seen as a Kantian categorical Imperative, and as such, it is posited as a Safety Imperative.

From this discussion, the safety impasse is viewed as not formed from a clash between normative ethical views of Teleology (Utilitarianism) and Deontology, but rather from a deeper place within applied Deontology. A safety impasse between federal agency perspectives is based on a clash between the normative perspectives of conditional safety Imperatives (the FRA) versus categorical safety Imperatives (the NTSB).

Overcoming a safety impasse is not seen as a matter of taking actions above and beyond one's duty (supererogatory actions) but rather by focusing on the commonality in the normative ethical approach, which is duty-based (deontology); it is to keep passengers, employees and the public safe. This is the Safety Imperative: Be Safe!

Resolving the safety impasse can be accomplished by the FRA re-examining its mission, as Be Safe!, Do X!, and give examples of X, instead of rules (Y) to follow to accomplish X. This shift in wording, and shift in emphasis, are actions that can be accomplished following the steps upward through the Moral Process Framework. This can lead the way towards an organizational shift within worldviews, from deontological conditional safety Imperatives to deontological categorical Imperatives; that is, to an agency philosophy driven by a Categorical Safety Imperative: Be Safe!

CHAPTER FOUR

CONCLUSION AND FUTURE WORK

This chapter begins by discussing areas for future work that are based on the last two areas of the duty-based analysis on the Ishikawa Diagram: The Corporate Assessment and the Public Safety Assessment. This is followed by a brief review of the first three chapters and conclusions drawn from them.

Future Work

Additional future areas of work remain and are shown on the Ishikawa Diagram as the last two types of assessments within the framework of a duty-based analysis. Those are a Corporate Assessment of passenger rail corporations and a Public Safety Assessment of passenger rail safety disparities.

The former examines corporate stakeholders' actions and plans using environmental, social and governance criteria (ESG). A Corporate Assessment would ask questions of an organization, such as Amtrak, looking at how their operations contribute, or impede, efforts to improve the organization's ESG aspects. This may offer alternate reasons for Amtrak to address the safety recommendations issued to the FRA, and to research and put in place additional passenger protections, such as seat belts. Thus, the ESG criteria may offer alternate reasons that compel action by the FRA or Amtrak on the NTSB's recommendations described in Chapter One. This would enable

the resolution of the safety impasse. Addressing ESG aspects would no longer be viewed as a supererogatory action but would be in keeping with achieving a new level of corporate and organizational ethos.

The latter, a Public Safety Assessment, would ask questions aimed at determining if actions or inactions led to disparities of harm inflicted on passengers in rail transportation. Here, harm can be an unintended consequence of actions or inactions, or a known or intended consequence of actions or inactions. The first purpose is to determine if the current levels of safety, as measured in people harmed, differ across demographic factors of gender, age, race, ethnicity, and socio-economic and geographic areas. However, the concept of passenger harm is not confined to victims of rail accidents.

A second area of interest is public safety and health issues associated with the COVID-19 plague. These require additional measures to ensure that the portion of the population who rely on mass public transportation are kept safe from biological and environmental harm during their transportation. Rail passengers who commute to work tend to not be in the highest socio-economic percentiles of the population, and they live or work in the higher population areas. Today, there is a heightened awareness of risk in high density areas, which cannot always be fully mitigated by social distancing or wearing Personal Protection Equipment (PPE). For example, across the passenger rail industry, there are multitudes of surfaces that are touched and need cleaning, which can

foster the transmission of a novel virus. Also, the rate of ventilation and air purification or sterilization is limited in confined areas such as rail cars. New and more creative risk mitigation measures are needed, to include more frequent and thorough cleaning of rail cars and terminals, mandatory PPE, social distancing of passengers and crew, redesigning rail cars, platforms and terminals to allow more protective barriers between people, and potentially fewer people using mass transportation systems such as rail.

This area of harm disparity research has been important and active in the medical field for several decades.[1] There has been some research done in this area, of safety disparities in rail trespasser fatalities, funded by the Federal Transportation Administration (FTA). However, there were methodological flaws that rendered it inconclusive, as with the FRA's human factors research described in Chapter Two.

A deeper look at the FRA's human factors research is actually a good starting point for understanding harm disparity, as it has a fifth methodological flaw that was not discussed in Chapter One. It is a problem with the population percentile ranks that the crash dummies represent. Data reports from the Department of Health and Human Services Centers for Disease Control and Prevention indicate significant variations in

[1] An example is a research study conducted by the Center for International Blood and Marrow Transplant Research (CIMBTR) which investigated causal factors for inferior access to medical care based on age and income levels. As a member of the research team, I worked on the methodology of the research protocols. For more information, see Paulson, K., et. al., "Inferior Access to Allogeneic Transplant in Disadvantaged Populations: A CIBMTR Analysis," in *Biology of Blood and Marrow Transplantation*, 25, no. 10 (October 2019): 2086-2090.

height and weight percentile ranks, based on gender, age, race and ethnicity.[2] Therefore, the results from the FRA research tests utilizing crash dummies at the 5th and 95th percentiles represent differing percentages of subsets of the population depending on age, gender, race and ethnicity, which may indicate a safety disparity. This highlights a need for a multivariate approach to anthropometry to account for different degrees of variance in the height and weight of the rail transportation user population.

This type of Public Safety Assessment would be beneficial to ensure that when moving the safety needle forward, it moves commensurably forward across all people equitably.

It is not enough to state the simple Categorical Imperatives; Be Safe! Do not Kill! Today's heightened risks to passenger safety calls for a clear, unequivocal understanding of safety for all people, of all demographic and socioeconomic sectors of the population. This must begin in the methodological protocols for passenger safety research and translate through to rail passengers on trains and platforms. In the medical field, the translational aspect is from bench to bedside. We must determine a parallel translational aspect in rail transportation safety, from the safety research "bench" to passenger platforms, terminals, and rail cars across the country.

[2] Fryar, Cheryl D., Kruszon-Moran, Deanna, Gu, Qiuping, and Ogden, Cynthia, "Body Mass Index Among Adults: United States, 1999-2000 Through 2015-2016," in *National Health Statistics Reports*, 122, (December 20, 2018): 12-16.

This, for society, is the Translational Categorical Safety Imperative: to ensure that rail transportation safety measures, developed through research and analysis, or through the safety recommendation process, are translated to rail applications that achieve the same safety goals for all people, across all sectors of society, regardless of socio-economic and demographic factors.[3] This may be achieved through safety equity.

A three-step process for safety equity is posited:

1) develop and implement a data-driven process to determine the existence, and extent, of transportation safety disparities.

2) develop and implement an evidence-based methodology to measure future safety equity outcomes in terms of injuries and fatalities.

3) revise safety management systems to identify and resolve transportation safety disparities and ensure transportation safety equity for all people.

Conclusion

A Moral Framework for improving passenger rail safety has been presented in the preceding three chapters. Chapter One provided examples of two passenger rail

[3] Garcia, Anne. L. and James Giordano, "Bioethical Trends in Transitioning from Basic Hematopoietic Stem Cell Research thru the Translational Research Cycle (T1-T4)." *Experimental Hematology: Journal for Hematology, Stem Cell Biology and Transplantation*, 41, no. 4 (August 2013): 914-17; Garcia, Anne L., G. Palchik, and James Giordano. "Toward a Neuroethically-grounded Translational Imperative for Neuroscience: From BRAIN to Bench - to Bedside." Paper presented at the International Neuroethics Society Conference, San Diego, CA, November 10, 2013. These two references are examples of my work in bioethics, toward determining the Translational Imperative within the medical field.

accidents, described the safety recommendations and explained the resulting safety impasse between the NTSB and the FRA.

Possible reasons for the safety impasse were examined. The first focused on evidence-based issues and reviewed the FRA's approach to human factors research on rail passenger protection. Methodological flaws in the human factors research were reviewed, and based on this, the differences in evidence-based conclusions were rejected as the basis for a safety impasse. By examining the Moral Process, the safety impasse is seen as a moral impasse and the investigation of the underlying cause of a moral safety impasse shifted from an evidence-based approach to a duty-based approach. A duty-based analysis was constructed, founded on the Moral Process, and consisting of a Harm Assessment and a Normative Assessment.

From there, a second possible reason for the safety impasse was examined, based on human flaws, that is, problems with the Will that lead to inaction. This was coupled with the issue of fore-knowledge and formed the basis for a Harm Assessment.

A third possible cause for the impasse was examined through a Normative Assessment and is based on clashing worldviews; the Teleological and the Deontological. Within the Deontological, the differences between the Kantian Categorical Imperative and Kantian Conditional Imperative form the basis for the safety impasse between the FRA and the NTSB, as demonstrated in the rail accident examples from Chapter One.

The moral framework proffered here for understanding safety impasses and moving toward a resolution is extensible and can be useful for understanding and hopefully, resolving older safety impasses. They can be treated as cold-case investigations through a new lens of inquiry, and by resolving them, effectively moving the safety needle forward, toward a passenger rail system with zero fatalities and injuries to the passengers, employees, and the public writ large. If this occurs, ethics will have another cornerstone in influencing practical and significant public problems.

Thus, the duty-based analysis, developed to determine the cause of a safety impasse and identify areas to be examined, is aimed at resolving current safety impasses and preventing safety impasses in the future. The outcome of the duty-based analysis is presented as a movement towards the formation of a societal Safety Imperative, as an instance of a Kantian Categorical Imperative, which may serve as a guide for resolving safety impasses.

This final chapter looked towards future work; less at tactical responses to rail accidents and more toward strategic planning to impact imminent concerns for rail passenger safety. Two areas of assessment were offered. First, a Corporate Assessment may examine environmental, social and corporate governance areas.

Next, a Public Safety Assessment may examine actions and plans of public safety stakeholders using safety criteria applied across societal groups relying on public rail transportation systems. Two examples were provided. The first concerns lessons learned

in determining and maintaining safe and healthy rail transportation environments for passengers through the development of new rail transportation sanitization protocols and procedures during the COVID-19 global pandemic. The second is ensuring that rail transportation safety measures, whether developed through research and analysis, or through the safety recommendation process, are effectively and equitably translated and implemented to achieve the same safety outcomes for all people, across all sectors of society, regardless of socio-economic and demographic factors. This is the Translational Categorical Safety Imperative for transportation. This is the moral high bar that must be achieved to successfully improve rail passenger safety for all.

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