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Behind the Numbers: A Trend Synthesis of Publicly Reported Indonesian Marine Casualty Investigation Data

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ABSTRACT

Indonesia's National Transportation Safety Committee (KNKT) has investigated marine casualties for nearly two decades, yet the statistics its reports and secondary analyses have produced remain scattered across studies with different time windows and units of analysis, preventing a coherent view of what has actually changed. This study synthesises publicly reported KNKT-derived marine casualty statistics spanning 2007 to 2025 from four independent sources, coding each for time period, accident category, and contributing factor to construct a trend account without requiring new access to raw KNKT case files. The synthesis indicates a declining investigation caseload from 2019 to 2023 followed by a sharp resurgence in 2024, a persistent and disproportionate concentration of fatalities in small fishing vessels that fall partly outside KNKT's formal investigation threshold, and a consistent, multi-decade dominance of human error as the leading contributing factor across every reporting period examined. The study's principal contribution is identifying a structural data-visibility gap — Indonesia's marine casualty statistics substantially undercount vessels below the 100-gross-tonnage investigation threshold — as a more consequential limitation than any single year-on-year fluctuation in the reported trend.

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1. INTRODUCTION

A national accident-investigation body's statistics are only as informative as the boundary drawn around what counts as an investigable accident, and Indonesia's National Transportation Safety Committee (Komite Nasional Keselamatan Transportasi, KNKT) operates under a boundary that is easy to overlook and consequential once noticed: Government Regulation No. 62 of 2013 restricts KNKT's mandatory marine investigation authority to vessels of 100 gross tonnage or more, a threshold that excludes the great majority of Indonesia's small fishing and traditional coastal fleet from routine formal investigation even when casualties involving those vessels are, by volume, numerous [1]. This single regulatory design choice shapes everything that follows from KNKT's published statistics, including every academic study, including the present one, that treats those statistics as a proxy for Indonesia's actual marine safety performance rather than as a partial, tonnage-filtered window onto it.

Within that window, however, a substantial and informative body of evidence has accumulated. Early systematic analysis of KNKT investigation reports covering 2007 to 2014 found that the dominant recorded contributing factors were human error, technical failure, and weather, with correspondence analysis revealing specific associations between accident type — sinking, capsizing, grounding, or collision — and vessel and route characteristics [2]. This foundational finding, that human error recurs as the leading contributing factor across a documented eight-year investigation window, is not an isolated result: more recent secondary compilations of KNKT reporting indicate that in 2019 alone KNKT conducted seventy-two investigations, the majority in the shipping sector and featuring a marked rise in collision cases, and that a subsequent 2022 report again recorded a dominance of technical failure modes such as collision and capsizing [3]. Separately, KNKT's own end-of-2021 reporting found that fishing vessels accounted for roughly one-third of all marine accidents investigated between 2018 and 2020, with an estimated one hundred deaths per year in this segment and 342 cumulative fatalities over the three-year window [4] — a segment-specific statistic with no direct counterpart in the general shipping-accident literature reviewed above, because fishing vessels sit closest to, and often below, the 100-gross-tonnage investigation threshold that structures KNKT's formal mandate [1].

More recent reporting complicates any simple narrative of steady improvement or steady decline. The same secondary compilation reporting the 2019 and 2022 figures also indicates a marked decline in investigated shipping accidents by 2023, with only seven cases recorded that year, before a reported 37.6% increase in 2024 investigation activity spanning six major accidents across multiple transport modes including shipping [3]. Read naively, a three-year decline followed by a sharp single-year increase might suggest either a genuine safety deterioration in 2024 or, alternatively, a change in investigation intensity, reporting practice, or accident severity thresholds that has nothing to do with underlying safety performance — a distinction the existing literature, considered study by study, does not resolve, because no published source has yet placed these separately reported figures on a single continuous timeline.

This fragmentation matters because Indonesian domestic shipping safety research increasingly treats KNKT data as a key empirical anchor. Recent structural modelling of Indonesian domestic Ro-Ro and passenger/cargo shipping risk explicitly draws on KNKT accident data for 2020 to 2025 to argue that human error remains the dominant contributing factor even after decades of SOLAS, STCW, and ISM Code implementation, positioning safety culture as the key mediating variable between crew competence, job stress, and accident risk [5]. This claim is consistent with, but was developed independently of, the earlier 2007–2014 correspondence-analysis finding [2] and the 2018–2023 secondary compilation [3], [4] reviewed above; no existing study has verified whether the human-error dominance these three independent evidence sources each report, spanning nearly two decades and drawn from non-overlapping analytical methods, in fact describes a single continuous pattern or three separate period-specific findings that happen to resemble one another.

This study therefore synthesises publicly reported, KNKT-derived marine casualty statistics from four independent sources spanning 2007 to 2025 into a single trend account, addressing three objectives: first, to place the separately reported investigation caseload and accident-category figures from each source onto a common timeline; second, to determine whether human error's reported dominance as a contributing factor is consistent across this timeline or varies by period; and third, to assess how the 100-gross-tonnage investigation threshold [1] shapes what this timeline can and cannot reveal about Indonesia's actual marine safety performance. The study's contribution is threefold. Empirically, it produces the first cross-period synthesis of Indonesia's fragmented marine casualty reporting literature, at no cost beyond the secondary analysis of already-published statistics. Methodologically, it demonstrates a transparent approach to synthesising heterogeneous, non-overlapping secondary statistical reporting when raw case-level data are not directly available to the researcher. Practically, it identifies which limitations in Indonesia's marine safety evidence base are genuine safety-performance findings and which are artefacts of the investigation threshold itself, a distinction with direct relevance to how KNKT statistics should and should not be used in future safety-culture and policy research.

2. LITERATURE OR THEORETICAL REVIEW

Accident investigation statistics are conventionally treated in the safety literature not as a neutral record of "what happened" but as the product of an investigation system's own scope, thresholds, and reporting practices, a distinction organisational accident theory makes explicit by separating the occurrence of unsafe conditions from an institution's capacity to detect and record them [6]. Applied to KNKT specifically, this distinction is not abstract: Indonesia's Government Regulation No. 62 of 2013 defines KNKT's investigation mandate around a 100-gross-tonnage threshold [1], meaning that the population of accidents KNKT investigates, and therefore the population its published statistics describe, is a tonnage-filtered subset of Indonesia's total marine casualty experience rather than a complete census of it. This is directly consequential for interpreting the fishing-vessel fatality

statistics reported for 2018–2020 [4], since small fishing vessels are precisely the fleet segment most likely to fall below or near this threshold, meaning that even KNKT's own reported fishing-vessel fatality count likely understates, rather than fully captures, the true toll in this segment.

Within this bounded population, the dominant analytical finding across the literature is the persistence of human error as the leading recorded contributing factor. The earliest systematic treatment, applying multiple correspondence analysis to KNKT investigation data from 2007 to 2014, found human error alongside technical failure and weather as the principal contributing factors, with specific accident types — collision in particular — associated with identifiable vessel and route characteristics [2]. This finding sits within a broader theoretical account in which safety climate — what an organisation's personnel actually understand to be tolerated in practice, as distinct from stated policy [7] — mediates the relationship between individual-level factors such as crew competence and fatigue and vessel-level accident risk, an account explicitly operationalised in recent structural modelling of Indonesian domestic Ro-Ro and passenger/cargo casualty data for 2020–2025 [5]. That the same human-error-dominant pattern recurs across a 2007–2014 correspondence-analysis study [2] and a methodologically distinct 2020–2025 structural model [5], despite the thirteen-year gap and complete change in analytical method between them, is itself a form of corroboration that neither study alone can claim, since consistency across independent methods and periods is a stronger form of evidence than either result considered in isolation.

The literature is considerably less settled, however, on short-term year-to-year fluctuation, which secondary compilations of KNKT reporting describe in seemingly contradictory terms: a declining shipping-sector investigation caseload from 2019 through 2023, followed by a sharp reported increase in 2024 [3]. Accident-statistics methodology generally treats such short-term fluctuation with caution, since changes in reported caseload can reflect genuine changes in underlying accident frequency, changes in an investigation body's case-selection or severity criteria, or simple year-to-year randomness in a comparatively low base-rate phenomenon, and distinguishing between these explanations typically requires a longer, methodologically consistent time series than the fragmented secondary reporting synthesised in this study can, on its own, provide.

No existing source has attempted to place these separately reported statistics — the 2007–2014 correspondence-analysis findings [2], the 2018–2020 fishing-vessel fatality figures [4], the 2019–2024 investigation-caseload figures [3], and the 2020–2025 structural risk model [5] — onto a single continuous account, nor has any source explicitly evaluated how the underlying 100-gross-tonnage investigation threshold [1] should condition confidence in any resulting trend claim. This is the gap the present synthesis addresses: not by generating new casualty data, but by reading the existing fragmented reporting as a single, threshold-aware evidentiary record for the first time.

3. METHOD

This study conducts a secondary trend synthesis of publicly reported, KNKT-derived marine casualty statistics, explicitly not a re-analysis of raw KNKT case files, which were not accessed for this study. This methodological choice is stated at the outset because it directly shapes what the study can and cannot claim: the analysis synthesises numbers and findings that other researchers or KNKT itself have already published, rather than independently deriving new statistics from primary accident records. The population of interest comprised published sources reporting quantitative or categorical statistics derived from KNKT marine accident investigations, identified through structured search of academic and institutional sources and retained where they reported a specific, attributable time period, accident count, or category breakdown rather than only a general narrative claim about Indonesian marine safety.

Four sources met this criterion, together spanning a non-continuous but substantially informative eighteen-year window: a peer-reviewed correspondence-analysis study of KNKT investigations from 2007 to 2014 [2]; KNKT's own end-of-2021 reporting on fishing-vessel accidents and fatalities for 2018–2020 [4]; a secondary compilation of KNKT investigation-caseload figures for 2019, 2022, 2023, and 2024 [3]; and a structural risk model applying KNKT accident data for 2020–2025 to Indonesian domestic Ro-Ro and passenger/cargo shipping [5]. The regulatory scope-defining source, Indonesia's Government Regulation No. 62 of 2013 [1], was additionally reviewed to establish the investigation-threshold context within which all four statistical sources must be interpreted.

The primary instrument for this synthesis was a chronological extraction table, recording for each source its covered time period, the specific statistic or finding reported, the accident or vessel category to which it applied, and any explicitly stated methodological caveat (such as investigation-threshold scope) affecting its interpretation. Data collection consisted of close reading of each source to extract only explicitly stated quantitative or categorical claims, avoiding any inference of figures not directly reported.

Data analysis proceeded through chronological sequencing of the extracted statistics onto a single

timeline, followed by thematic analysis identifying recurring categories (contributing-factor dominance, vessel-segment risk concentration, investigation-caseload fluctuation) across the four non-overlapping reporting periods, consistent with established qualitative synthesis coding practice [8]. Cross-period comparison was then applied specifically to the human-error contributing-factor finding, given its independent appearance in both the earliest [2] and most recent [5] sources, to assess whether this represented a single persistent pattern or two coincidentally similar but analytically distinct findings. Narrative synthesis integrated the resulting timeline and thematic findings into the threshold-aware trend account presented in Section 4.

4. Results and Analysis

Table I presents the chronological extraction table produced through the synthesis procedure described in Section 3, sequencing the four sources' reported statistics onto a single, threshold-aware timeline.

Table I. Chronological Synthesis of Publicly Reported KNKT-Derived Marine Casualty Statistics

Period	Source	Reported Statistic / Finding	Category
2007–2014	Hasugian et al. [2]	Human error, technical failure, and weather identified as principal contributing factors via correspondence analysis; collision type associated with specific vessel/route characteristics	Contributing factor
2018–2020	KNKT (reported in [4])	~31% of investigated marine accidents involved fishing vessels; ~100 fatalities/year in this segment; 342 cumulative fatalities	Vessel-segment risk
2019	Secondary compilation [3]	72 KNKT investigations conducted, majority in shipping sector, rising collision incidence	Investigation caseload
2022	Secondary compilation [3]	Reported dominance of collision and capsizing (technical failure modes)	Contributing factor
2023	Secondary compilation [3]	Only 7 shipping accident cases investigated; described as a 3-year declining trend	Investigation caseload
2024	Secondary compilation [3]	37.6% increase in investigation activity; 6 major accidents across transport modes	Investigation caseload
2020–2025	Faturachman et al. [5]	Human error remains dominant contributing factor in domestic Ro-Ro/passenger-cargo casualties despite SOLAS/STCW/ISM implementation	Contributing factor
(Regulatory scope)	GR No. 62/2013 [1]	Mandatory KNKT investigation limited to vessels ≥100 GT	Investigation threshold



Figure 1. Reported KNKT Shipping-Sector Investigation Caseload, Selected Years

The synthesis in Table I supports three distinct findings, each with a different degree of evidentiary confidence. The strongest finding, because it is corroborated independently across the two most methodologically distinct and temporally distant sources in the corpus, is the persistence of human error

as the leading recorded contributing factor: the 2007–2014 correspondence-analysis study [2] and the 2020–2025 structural risk model [5] reach this conclusion through entirely different analytical methods, separated by roughly a decade with no overlapping data or shared authorship, yet converge on the same substantive finding. This convergence, following the logic that independent-method agreement constitutes stronger evidence than either method alone, is the synthesis's most defensible trend claim: human-error dominance in Indonesian marine casualties is not a period-specific artefact but a persistent, multi-decade pattern.

A methodological clarification is necessary before treating the 2007–2014 and 2022 findings as fully consistent with one another, since the two studies report findings in different units of analysis rather than strictly the same statistic. The 2007–2014 correspondence-analysis study [2] reports human error, technical failure, and weather as contributing factors — the underlying cause of an accident — whereas the 2022 secondary compilation [3] reports collision and capsizing as dominant accident types — the physical form an accident takes, which any of several contributing factors could produce. These are complementary rather than contradictory categories: a collision, the accident type the 2022 report emphasises, is frequently caused by human error, the contributing factor the 2007–2014 and 2020–2025 studies emphasise, meaning that a rise in reported collision incidence is fully consistent with, rather than a departure from, the multi-decade human-error-dominance finding. This distinction matters because conflating accident type with contributing factor would create an appearance of inconsistency across the four sources that the underlying data do not actually support once the two categories are kept separate.

The reported statistics also permit one further, explicitly bounded cross-reference between two figures reported by different sources. If fishing vessels accounted for approximately 31% of accidents investigated between 2018 and 2020 [4], and KNKT's 2019 shipping-sector investigation caseload alone reached 72 cases [3], a simple, illustrative combination of these two independently reported figures suggests a fishing-vessel-accident caseload on the rough order of twenty cases within that single year — a figure neither source reports directly and which this synthesis does not treat as a new, independently verified statistic, but which usefully illustrates the practical scale of the vessel-segment risk-concentration finding discussed below in terms an isolated percentage figure does not immediately convey. This calculation should be read as an interpretive aid bounded strictly by the two reported figures it combines, not as a new data point with independent evidentiary standing.

The second finding, visible in Figure 1, concerns short-term investigation-caseload fluctuation, and here the evidentiary confidence is markedly lower. The reported decline from 72 shipping-sector investigations in 2019 to only 7 in 2023, followed by a 37.6% increase in 2024 [3], is a striking pattern on its face, but the synthesis in Section 2 flagged precisely the interpretive ambiguity this pattern raises: without independent information on whether KNKT's case-selection criteria, severity thresholds, or reporting practices changed across this period, a tenfold-magnitude swing in reported caseload cannot be confidently attributed to an equivalent underlying change in actual accident frequency. This is not a failure of the present synthesis but a limitation inherited directly from the secondary source itself, which does not report the methodological detail needed to adjudicate between a genuine safety trend and an investigation-practice artefact.

The third finding concerns vessel-segment risk concentration and is the finding most directly conditioned by the 100-gross-tonnage investigation threshold [1]. The reported 2018–2020 fishing-vessel statistics — roughly one-third of investigated accidents and a cumulative 342 fatalities [4] — describe a segment of the fleet disproportionately exposed to risk, but because small fishing vessels sit at or below the very threshold that defines KNKT's mandatory investigation scope, this reported figure is itself likely a floor rather than a ceiling on the segment's true casualty burden: fishing-vessel accidents below the threshold, or those never formally reported to KNKT at all, are structurally excluded from every statistic synthesised in this study, including the multi-decade human-error finding discussed above. This threshold effect means that Indonesia's actual small-vessel and fishing-fleet safety performance may be considerably worse than any figure in Table I indicates, not because the reported data are inaccurate, but because they were never designed to capture that population fully.

Considered together, these three findings support a layered rather than a single-headline conclusion: strong, multi-decade evidence for persistent human-error dominance; weak, threshold- and practice-confounded evidence for any specific recent-year improvement or deterioration trend; and a structural reason to expect that Indonesia's most safety-vulnerable fleet segment is the one least visible in the very statistics this and other studies rely on.

5. DISCUSSION

This synthesis set out to place Indonesia's fragmented, secondary-reported marine casualty statistics onto a single timeline, assess the consistency of human-error dominance across that timeline, and evaluate how the 100-gross-tonnage investigation threshold shapes what the resulting trend account can support. The findings answer the second of these

questions with the greatest confidence: human error's dominance as a contributing factor is corroborated independently across a 2007–2014 study and a 2020–2025 study using entirely different methods [5], [2], a form of triangulation that neither individual finding could achieve alone and that directly reinforces the safety-culture-mediated risk models increasingly used in current Indonesian domestic shipping research [5].

This finding carries a specific theoretical implication for how that dominant contributing factor should be interpreted. Organisational accident theory holds that "human error" recorded as a proximate contributing factor is typically the visible endpoint of latent organisational conditions rather than a sufficient explanation in itself [6], meaning that the multi-decade persistence of human-error dominance identified in this synthesis is better read as evidence of a stable underlying latent-condition profile — the kind of persistent safety-culture and safety-climate gap documented in adjacent research on Indonesian domestic-international shipping [7] — than as evidence that individual seafarer competence or diligence has failed to improve over nearly two decades of maritime education investment. This reframing matters for policy: it argues against interventions targeted narrowly at individual crew training in isolation, and toward the same systemic, culture-level interventions that safety-culture research on this same fleet segment already recommends.

The synthesis's more significant contribution, however, is arguably its identification of what the assembled evidence cannot support rather than what it can. The apparent 2019–2024 caseload swing [3], read naively, might motivate a claim that Indonesian marine safety deteriorated sharply in 2024 after several years of improvement; the present synthesis's explicit methodological caution — that this swing is equally consistent with a change in investigation practice as with a change in underlying accident frequency — is a deliberately conservative reading that a less careful secondary use of the same reported figures might not have applied. Similarly, the identification of the 100-gross-tonnage investigation threshold [1] as a structural data-visibility gap is, in the authors' assessment, more consequential for future research and policy than any single year's reported figure, because it implies that Indonesia's most safety-vulnerable fleet segment — small fishing and traditional vessels — is systematically underrepresented in the very evidence base this and virtually all other KNKT-based studies rely on.

The study's principal limitation follows directly from its explicitly secondary-source design: because no raw KNKT case-level data were accessed, the synthesis cannot independently verify the reported figures, resolve the ambiguity in the 2019–2024 caseload swing, or quantify precisely how much the sub-100-GT threshold undercounts actual fishing-vessel casualties. The clearest and most consequential direction for future research is accordingly not a further secondary synthesis of published figures but a primary data-access study — ideally in direct collaboration with KNKT or Indonesia's Ministry of Transportation — capable of examining case-level investigation records and, where possible, supplementary data on sub-threshold vessel incidents that fall outside KNKT's mandatory investigation scope entirely.

6. CONCLUSION

This study synthesised publicly reported, KNKT-derived marine casualty statistics from four independent sources spanning 2007 to 2025, finding strong, cross-method corroborated evidence for persistent human-error dominance as a contributing factor, weak and practice-confounded evidence for any specific recent-year safety trend, and a structural data-visibility gap arising from KNKT's 100-gross-tonnage investigation threshold that likely understates risk in Indonesia's small fishing and traditional vessel fleet. The study's principal contribution is demonstrating that Indonesia's fragmented marine casualty reporting literature can be read as a single, threshold-aware evidentiary record without requiring new raw-data access, while cautioning against over-interpreting short-term caseload fluctuations that the existing secondary literature does not report in sufficient methodological detail to resolve. These findings argue for continued investment in systemic, safety-culture-level interventions over narrowly individual-level training reforms, and for future primary research capable of addressing the sub-threshold visibility gap this synthesis identifies but cannot itself close.

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