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Critical Analysis of Dangerous Goods Documentation and its Impact on Air Cargo Safety: An Empirical Study of Documentation Practices and Error Patterns

DR. S. Ramasubramanian[1], Fatima daisy[2], Ms. Kaviya. K[3]

[1]*Associate Professor, Department of Aviation, Vels Institute of Science, Technology and Advanced Studies Chennai – 600117, Tamil Nadu, India*

[2]*Assistant Professor, Department of Aviation, MH Cockpit Private Limited, Tamil Nadu – 600117, India*

[3]*Student (MBA – Aviation & Airport Management), Department of Aviation, Vels Institute of Science, Technology and Advanced Studies, Chennai – 600117, Tamil Nadu, India*

***Abstract*— This study investigates the role of dangerous goods (DG) documentation in air cargo safety. Dangerous goods — including flammable liquids, gases, toxic substances, radioactive materials, and lithium batteries — must be documented in accordance with ICAO Technical Instructions (Doc 9284) and IATA Dangerous Goods Regulations (DGR). In spite of these well-established rules, documentation errors continue to be a recurring problem in day-to-day cargo operations. Data were gathered through a structured questionnaire administered to 50 respondents — cargo staff and MBA aviation students in Chennai — along with interviews with seven cargo documentation practitioners. The results indicate that only 24% of respondents have full knowledge of IATA DGR; 62% come across documentation errors on a regular basis; just 44% consistently follow the mandatory DG checklist; and 56% point to time pressure as a direct reason for mistakes. Based on these findings, the study calls for wider adoption of digital documentation tools, more frequent and structured training, and tighter internal audit routines.**

***Keywords*— Air cargo safety, dangerous goods documentation, IATA DGR, ICAO regulations, documentation errors, digital documentation, freight forwarding.**

I. Introduction

Air cargo has become one of the main arteries of global trade. Sectors such as pharmaceuticals, electronics, and e-commerce rely heavily on air freight because of its speed and reach. Within this broader cargo stream, a specific group of materials — classified as dangerous goods — demands a higher level of care at every stage of handling.

Dangerous goods cover a wide range of substances: flammable liquids, compressed gases, oxidizing agents, toxic chemicals, radioactive materials, corrosives, and lithium batteries. The IATA DGR groups them into nine hazard classes, each with its own rules on packaging, labelling, and documentation.

Lithium batteries deserve particular attention — they are present in virtually all consumer electronics and account for a growing share of cargo fires.

Flying adds hazards that simply do not exist on the road or at sea. The drop in cabin pressure as the aircraft climbs can cause liquid containers to swell and leak. Temperatures in cargo holds swing between extremes depending on the route and aircraft type. Hours of engine vibration can work loose the seals on even securely packed items. Critically, once the doors close and the aircraft pushes back, there is no option to intervene — which is why correct documentation before departure is not a formality but a genuine safety requirement.

The documentation set for a DG shipment typically consists of the Shipper's Declaration for Dangerous Goods (SDDG), the Air Waybill, a Safety Data Sheet, and a Packaging Certificate. Together, these tell ground crew, loaders, and the flight crew what they are carrying and what to do if something goes wrong. An error in any of these — a wrong UN number, an incorrect packing group, a missing emergency contact — can have real consequences in the air.

This study set out to understand where and why documentation errors occur and what practical steps can reduce them. Specifically, it aims to: (i) assess how well cargo staff know the IATA DGR requirements; (ii) measure how frequently documentation errors arise; (iii) identify the main factors behind those errors; (iv) look at what they cost in safety and operational terms; and (v) gauge how receptive the industry is to digital tools and structured training.

II. Review Of Literature

Chang et al. [1] analysed dangerous goods management priorities in air transport and found that documentation failures ranked among the most serious safety risks.

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Incorrect shipper declarations stood out as the single most consequential error type. Despite clear regulatory requirements, the authors noted that gaps in human performance repeatedly undermine compliance in practice.

Zhao et al. [2] constructed a safety assessment model for DG air transport. A key finding was that errors made during cargo acceptance — before loading — are the hardest to catch and therefore carry the greatest risk. Their model pointed to front-line acceptance staff competency as the most critical variable in the safety chain.

Thompson et al. [3] carried out a survey of cargo staff and established a direct link between heavy workloads and incomplete shipper declarations. Their practical recommendation — standardised checklists — reflects the reality that well-designed tools reduce the burden on individual memory and judgement, especially when staff are pressed for time.

Schmidt et al. [4] tracked the shift from paper to digital DG documentation across several European freight hubs and recorded a 40% fall in data-entry errors. They attributed this primarily to automated validation — the ability of digital systems to cross-check a declared UN number against the correct hazard class and packing group before the shipment is accepted.

Williams et al. [6] ran a controlled comparison between ground staff who had received recent DG training and those who had not. Trained staff produced 60% fewer rejected documents. The study also raised an important timing issue: because IATA revises its DGR annually, training that is more than two years old may no longer reflect current requirements.

Pillai and Krishnaswamy [7] focused on cargo personnel at Indian international airports and found significant gaps in IATA DGR knowledge, particularly around the more recent lithium battery regulations. Their findings are closely relevant to the present study and indicate that the awareness problem is not confined to a single organisation or location.

III. Research Methodology

A. Research Design

The study uses a descriptive research design that draws on both quantitative and qualitative data. Survey responses provide measurable figures on error rates and awareness levels, while the interviews offer first-hand accounts of what cargo documentation work actually looks like in practice.

B. Data Collection

A structured 18-item questionnaire was distributed to 50 respondents via Google Forms.

Participants included cargo operations staff and MBA aviation students who had completed internships in the Chennai air cargo sector. Convenience sampling was used, given the limited availability of operational staff for research participation.

The questionnaire covered four areas: knowledge of dangerous goods regulations; frequency and type of documentation errors; use of process controls such as checklists and audits; and views on digital tools and training. In addition, seven face-to-face interviews were held with experienced cargo documentation staff to gather qualitative detail. Secondary sources included ICAO Technical Instructions (Doc 9284), IATA DGR 65th Edition (2024), and peer-reviewed aviation management literature.

C. Data Analysis

Survey data were summarised using frequency counts and percentage analysis. Interview transcripts were reviewed for recurring themes through content analysis, and the two data sets were compared to check for consistency. Charts were prepared to make the key figures easy to read. Calculations were carried out in Microsoft Excel.

IV. Results And Discussion

A. DG Documentation Checklist Usage

The DG documentation checklist is the primary procedural check before a dangerous goods shipment is accepted. The data show that only 44% of respondents use it every time. The other 56% apply it sometimes, rarely, or not at all — meaning that in the majority of cases, this safeguard is not being used as intended.

Fig. 1: DG Checklist Usage

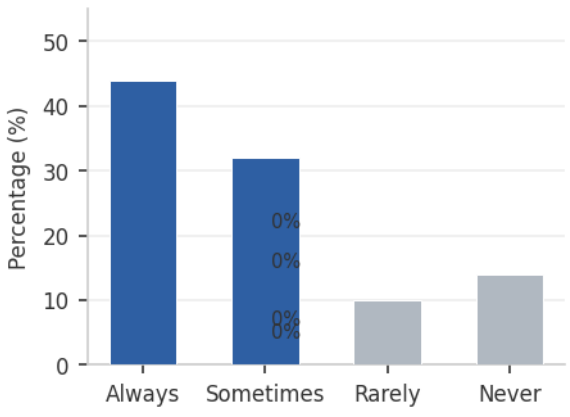

Fig. 1: DG Documentation Checklist Usage (n=50)

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IATA DGR makes checklist completion mandatory for all DG shipments, so treating it as optional is a straightforward compliance failure. The findings point to a need for organisations to enforce checklist use and verify through supervision that staff are actually following the procedure.

B. Awareness of IATA DGR

When asked about their familiarity with IATA DGR, only 24% of respondents described themselves as fully aware. A majority — 58% — said they are partially aware, and 18% admitted to having no awareness at all. In total, three-quarters of the sample are handling DG work without a complete understanding of the regulations that govern it.

Fig. 2: IATA DGR Awareness

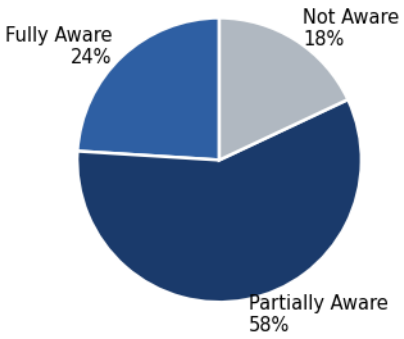

Fig. 2: Awareness of IATA DGR (n=50)

Partial awareness is a particular concern. Staff who know enough to feel confident, but not enough to catch their own errors, may be more likely to accept a flawed document than someone who flags uncertainty and asks for help. The pattern here mirrors findings from studies at other Indian airports [7], suggesting this is a sector-wide issue rather than an isolated one.

C. Frequency of Documentation Errors

A combined 62% of respondents come across documentation errors on a regular basis — 16% very often and 46% sometimes. Only one in seven (14%) reports never seeing an error. In interviews, the errors most commonly mentioned were wrong UN numbers, declarations that were incomplete, and incorrect packing group entries.

Fig. 3: Documentation Error Frequency

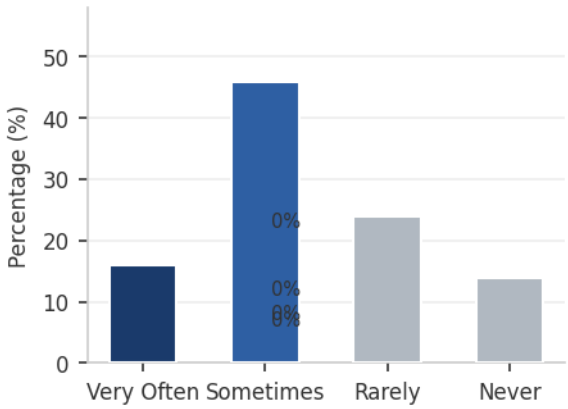

Fig. 3: Frequency of Documentation Errors (n=50)

The frequency of errors reported here is consistent with the broader literature. Chang et al. [1] found documentation-related non-compliance in roughly a third of dangerous goods incidents in their dataset. The present results suggest the situation in the Indian regional context is comparable.

D. Safety Impact of Documentation

62% of respondents agreed that how accurately documentation is completed has a direct bearing on safety. However, 24% said they were not sure — a reminder that for a meaningful share of cargo staff, the connection between a paperwork error and a physical safety failure is not yet fully understood.

Fig. 4: Safety Impact of Documentation

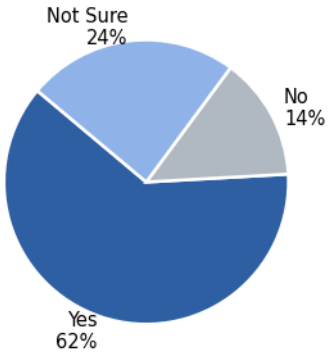

Fig. 4: Does Documentation Accuracy Affect Safety? (n=50)

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E. Shipment Rejections Due to Errors

Nearly half of respondents — 48% — said that shipments in their experience are frequently or occasionally turned away because of documentation problems. Beyond the obvious safety benefit of catching errors before loading, rejections carry real operational costs: flight delays, re-documentation work, and the risk of losing client trust.

Fig. 5: Shipment Rejections

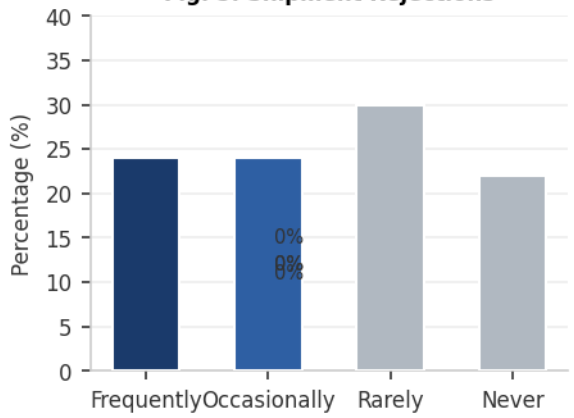

Fig. 5: Shipment Rejections Due to DG Documentation Errors (n=50)

F. Time Pressure and Documentation Errors

Just over half of respondents — 56% — agreed that time pressure leads to documentation mistakes. The acceptance window for cargo is typically two to four hours before departure. During peak periods, staff are often processing several shipments at once, leaving little room for careful checking. Only 10% of respondents disagreed with the idea that time pressure plays a role.

Fig. 6: Time Pressure → Documentation Errors

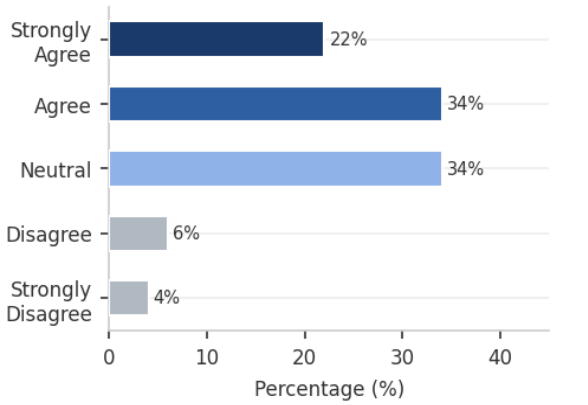

Fig. 6: Time Pressure as a Cause of Documentation Errors (n=50)

G. Digital Documentation Systems

60% of respondents felt that moving to digital DG documentation would bring down error rates. The appeal is straightforward: digital systems can check UN numbers automatically, flag mismatches against the DGR, and always reflect the most current rules. Only 12% disagreed. The 28% who were neutral may not yet be familiar with what tools like IATA's e-DGD system are capable of.

Fig. 7: Digital Documentation Reduces Errors

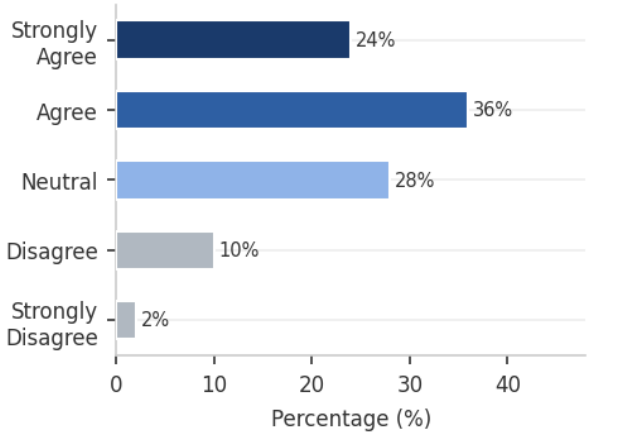

Fig. 7: Opinion on Digital Documentation Reducing Errors (n=50)

Schmidt et al. [4] recorded a 40% reduction in data-entry errors when European freight hubs switched to digital documentation. The level of support for digital tools among respondents in this study suggests that appetite for a similar shift exists in the Indian cargo sector.

H. Internal Audit Frequency

Only 30% of respondents work in organisations that conduct DG documentation audits on a regular basis. 40% audit only when prompted by an incident or inspection, and a further 30% rarely or never audit at all. Audits triggered by problems rather than scheduled proactively tend to catch issues after the fact rather than before.

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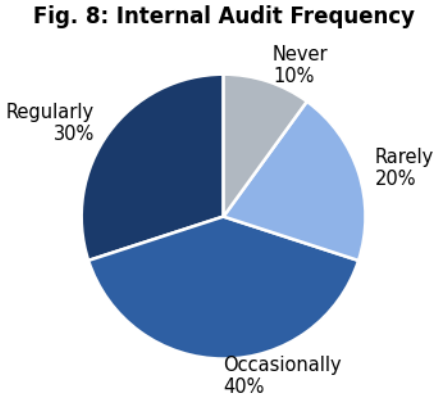

Fig. 8: Frequency of Internal DG Documentation Audits (n=50)

ICAO Annex 19 requires that Safety Management Systems include planned, proactive safety assurance activities. Auditing only in response to problems does not meet this standard. The data here indicate that most organisations in the sample fall short of what ICAO expects in this area.

V. Key Findings

- Checklist use is not consistent: more than half of respondents (56%) do not use the DG documentation checklist reliably, which removes the primary safeguard at the point of cargo acceptance.
- Regulatory knowledge is low: 76% of respondents have an incomplete or absent understanding of IATA DGR, which limits their ability to identify documentation problems.
- Errors are frequent: 62% come across documentation errors regularly. Wrong UN numbers and incomplete shipper declarations are the errors most often reported.
- Time pressure matters: 56% of respondents agree that tight deadlines during cargo acceptance lead directly to documentation mistakes.
- The operational cost is real: 48% report that shipments are frequently or occasionally rejected due to documentation problems, adding delays and cost to the supply chain.
- Digital tools have broad support: 60% believe digital DG documentation would reduce errors — a view consistent with the 40% error reduction reported in European studies after digital adoption [4].
- Auditing is mainly reactive: just 30% of respondents work in organisations with regular audit schedules, which is below the proactive standard that ICAO SMS frameworks require.

VI. Conclusion And Recommendations

A. Conclusion

Dangerous goods documentation is not an administrative afterthought — it is a core element of air cargo safety. This study identified clear and consistent gaps in the South Indian cargo sector: low checklist compliance, limited regulatory awareness, frequent documentation errors, and auditing that tends to happen after problems emerge rather than before.

These gaps are not mainly a matter of individual carelessness. They reflect workload conditions, training shortfalls, and systems that have not kept pace with the growing complexity of DG regulations. Addressing them requires action at the organisational level — not just reminders to individual staff.

The study adds to a relatively small body of research on DG documentation compliance in India. The patterns found here are likely to appear in other regional air cargo markets at a similar stage of development, making the findings relevant beyond the immediate study area.

B. Recommendations

- Adopt digital DG documentation: Airlines and freight forwarders should deploy systems with automatic UN number validation and live DGR compliance checks. IATA's e-DGD platform provides a well-established starting point.
- Require regular training: Regulators including DGCA and BCAS should mandate DG training on a two-year cycle for all cargo acceptance and handling staff, timed to coincide with IATA's annual DGR revisions.
- Address time pressure operationally: Staffing rosters and shipment scheduling should be reviewed so that staff have adequate time for documentation checks, particularly during the busiest periods.
- Move to planned auditing: Organisations should build scheduled DG documentation audits into their SMS calendar, rather than waiting for incidents to trigger a review.
- Make safety consequences tangible in training: Training programmes should directly connect specific documentation errors to their consequences — for example, showing how a wrong UN number can lead to the wrong emergency response in a cargo fire.

Future research should extend to multiple airports across India and draw on recorded safety incident data to test these findings at a larger scale.

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