

HALAL SLAUGHTER ASSISTANCE DURING EID AL-ADHA IN EAST KALIMANTAN, INDONESIA: A CROSS-SECTIONAL EVALUATION OF ANIMAL WELFARE CHALLENGES, HUMAN RESOURCE CAPACITY, AND COMMUNITY-BASED SLAUGHTER PRACTICES

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Abstract

Eid al-Adha concentrates the slaughter of thousands of cattle and goats into a few days, mostly at mosques, schools and neighbourhood sites without abattoir facilities. Indonesia meets this demand with volunteer and semi-professional halal slaughterers, but little is known about how that assistance is deployed. This cross-sectional study analysed aggregated post-event reports from officers of Dakwah Sembelih Halal (DSH) East Kalimantan for Eid al-Adha 1447 H (2026), covering 156 sites in six regencies and cities, 1,115 animals (749 cattle or buffalo, 366 goats) and 743 personnel. We used chi-square tests, Wilson 95% confidence intervals and directed content analysis against the Five Domains model. Samarinda accounted for 71.2% of sites and 66.3% of animals. Animal load per site departed from site share ($\chi^2 = 254.3$, $P < 0.001$), ranging from 3.5 animals per site in Kutai Kartanegara to 17.8 in Balikpapan, and species mix differed by region ($\chi^2 = 28.8$, $P < 0.001$; Cramér's $V = 0.16$). DSH officers performed the neck cut at 97.4% of sites (95% CI 93.6-99.0), casting at 62.8% (55.0-70.0) and skinning at 34.0% (27.0-41.7). Officers ranked a shortage of skilled skinners and non-uniform casting technique as the two most frequent constraints. Trained labour was concentrated at the cut, while handling before it and carcass work after it relied on untrained committees. A standard casting protocol, a skinner training track, load-based deployment and animal-based indicators in the reporting form would address the largest gaps.

Keywords:

Animal welfare; casting and restraint; Eid al-Adha; halal slaughterer; human resource capacity

1. Introduction

Eid al-Adha involves the slaughter of cattle, buffalo, goats or sheep between the 10th and 13th of Dhu al-Hijjah. In Indonesia, much of this activity occurs at community sites such as mosques, pesantren, schools and neighbourhoods, using volunteer labour under national hygiene, welfare and halal requirements (Kementan, 2014). This creates an intensive slaughter period often involving personnel with limited annual experience. In halal slaughter without stunning, welfare depends strongly on restraint, neck-cut quality and the time to loss of consciousness. Poor restraint and cutting practices may increase pain, distress and time to collapse (Gibson et al., 2009; Gregory et al., 2008, 2010; Velarde et al., 2014; Johnson et al., 2015). These concerns are also consistent with the Islamic principle of ihsan, which emphasises humane handling and appropriate knife use (Grandin & Regenstein, 1994; Nakyinsige et al., 2013; Farouk et al., 2014; Aghwan & Regenstein, 2019).

Indonesian studies have identified welfare and safety challenges at community slaughter sites. In Samarinda, Wibowo et al. (2024) recorded falls or slips in 36.52% of 115 cattle and vocalisation in

15.65%, while Safitri et al. (2022) found differences in slaughter-stage scores between mosques and pesantren. Non-professional slaughterers may also face injury risks (Basturk et al., 2016; Caliskan et al., 2020; Oktay et al., 2021; Tapan et al., 2024). Training is therefore important for improving animal handling and slaughter practices (Hemsworth, 2003; Coleman & Hemsworth, 2014).

In Indonesia, halal slaughterer competence is supported by national standards (Kemnaker, 2014) and the Halal Product Assurance Law (RI, 2014). Dakwah Sembelih Halal (DSH) provides training and deploys trained personnel to community slaughter sites during Eid. However, existing studies have mainly examined individual sites rather than the distribution of trained personnel and field constraints across a province. Using DSH East Kalimantan reports for Eid al-Adha 1447 H (2026), this study aimed to describe the spatial and species structure of assisted slaughter, assess personnel allocation across slaughter stages, and classify field constraints and solutions to identify priorities for training and site preparation.

2. Materials and Methods

Study area

The study covered East Kalimantan Province, Indonesia. DSH officers were deployed to six of the province's regencies and cities: Samarinda City, Balikpapan City, Kutai Kartanegara Regency, Kutai Timur Regency, Paser Regency and Penajam Paser Utara Regency. Samarinda, the provincial capital, hosts the DSH secretariat. Sites comprised mosques, mushalla (small prayer halls), pesantren, schools, government offices and community groups. Sacrificial slaughter took place on Eid al-Adha 1447 H and the following tasyrik days in May 2026. Figure 1 summarises the study design and analytical workflow.

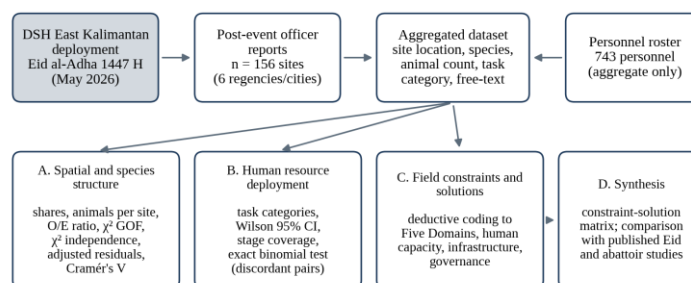


Figure 1. Study design and analytical workflow. Post-event officer reports from 156 slaughter sites were aggregated by the DSH East Kalimantan secretariat and analysed in four linked components (A–D).

Procedures

Study design and data source

We conducted a cross-sectional study based on secondary analysis of the official activity report of DSH East Kalimantan (DSH Kaltim 2026). After the event, each officer or team submitted a report giving the regency or city, the number of cattle or buffalo and goats handled, the task performed, the main constraints, the solutions applied, and suggestions for the committee and for DSH. The secretariat released these reports in aggregated form, by region and by category; site-level records were not available to the authors. We followed the STROBE checklist where items applied to aggregated data (von Elm et al. 2007).

Variables and definitions

Outcome variables were counts of sites, of animals by species (cattle and buffalo as a single category) and of task categories. Casting (perobohan) is bringing the animal into lateral recumbency and holding it for the cut, usually with ropes in community settings. Slaughter (sembelih) is the transverse ventral-neck incision that severs the trachea, oesophagus, both common carotid arteries and both jugular veins (MUI 2009; BSN 2016). Skinning (seset) is hide removal and initial carcass dressing. Each site fell into one of five mutually exclusive task categories: casting and slaughter; slaughter only; complete (casting, slaughter and skinning); slaughter and skinning; and skinning only. From these we derived three stage-coverage indicators: the proportion of sites at which DSH personnel performed casting, the neck cut, or skinning. Personnel were reported only as a provincial total (743). We recomputed all totals and percentages; species and site counts summed to 1,115 animals (749 cattle or buffalo, 366 goats) and 156 sites, matching the report. Three minor editorial inconsistencies in the report (table row order, the word cattle used for all large ruminants, and two forms of the organisation name) did not affect any count.

Data analysis

Regional patterns were described using site and animal shares, animals per site, the observed-to-expected (O/E) ratio, and the Herfindahl-Hirschman Index. A chi-square goodness-of-fit test assessed whether animal distribution differed from site-proportional allocation, while Spearman's rank correlation examined the association between site and animal counts. Species composition was tested using a chi-square test of independence, with Paser merged with Penajam Paser Utara because the expected goat count was below five. Adjusted standardised residuals ($|r| > 1.96$) identified deviations from independence, and Cramér's V measured effect size. Task coverage was estimated using Wilson 95% confidence intervals and chi-square tests, while casting and skinning coverage were compared using an exact McNemar test. Personnel per site and animals per person were also calculated.

The eight constraints, field solutions, and recommendations were coded using directed content analysis (Hsieh & Shannon, 2005), based on the Five Domains model and three operational dimensions: human resources, infrastructure and equipment, and governance and coordination (Mellor, 2017; Mellor et al., 2020). Because constraints were reported by rank without frequencies, rankings were treated as ordinal. Constraint-solution relationships were scored as 0 (no link), 1 (partial/indirect), or 2 (direct). All analyses were conducted in Python 3 using SciPy, with $\alpha = 0.05$.

Ethical considerations

The study used aggregated organisational data that contained no personal identifiers, and no animal was handled for research purposes. DSH East Kalimantan granted permission to analyse and publish the report. [Insert ethics committee approval number or waiver statement.]

3. Results

Spatial concentration of assisted slaughter

DSH received reports from 156 sites covering 1,115 animals (Table 1). Samarinda contributed 111 sites (71.2%) and 739 animals (66.3%). Site and animal counts ranked the regions in a similar order (Spearman $\rho = 0.93$, $P = 0.008$), and the Herfindahl-Hirschman index (0.54 for sites, 0.48 for animals) indicated strong concentration in the provincial capital. Load per site, however, departed from site share ($\chi^2 = 254.3$, $df = 5$, $P < 0.001$). Balikpapan handled 2.5 times its expected share (17.8 animals per site) and Penajam Paser Utara 2.1 times (15.0 per site), whereas Kutai Kartanegara handled half its expected share (3.5 per site across 25 sites) (Figure 2).

Table 1. Distribution of reporting sites and sacrificial animals handled by DSH East Kalimantan by regency and city, Eid al-Adha 1447 H (2026)

Region	Sites (n)	Sites (%)	Animals (n)	Animals (%)	Animals per site	O/E	Rank (animals)
Samarinda City	111	71.15	739	66.28	6.66	0.93	1
Kutai Kartanegara Regency	25	16.03	88	7.89	3.52	0.49	3
Balikpapan City	11	7.05	196	17.58	17.82	2.49	2
Kutai Timur Regency	5	3.21	54	4.84	10.80	1.51	4
Paser Regency	2	1.28	8	0.72	4.00	0.56	6
Penajam Paser Utara Regency	2	1.28	30	2.69	15.00	2.10	5
Total	156	100.00	1,115	100.00	7.15		

Note: O/E = observed animals divided by animals expected under site-proportional allocation (site share $\times$ 1,115). Goodness-of-fit against site-proportional allocation: $\chi^2 = 254.3$, $df = 5$, $P < 0.001$. Source data: DSH Kaltim (2026).

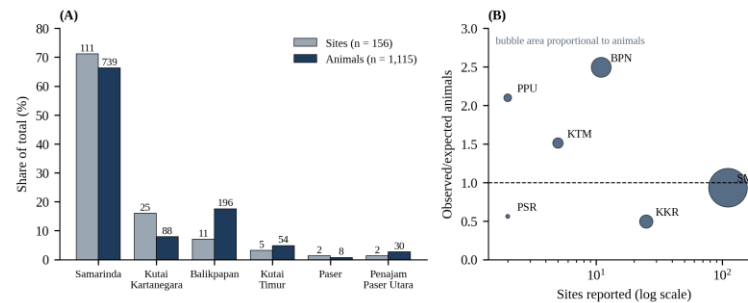


Figure 2. Spatial structure of DSH-assisted slaughter. A. Share of reporting sites and animals by region (numbers above bars are counts). B. Observed-to-expected animal load plotted against number of sites; the dashed line marks site-proportional allocation (O/E = 1) and bubble area is proportional to animals handled. SMD: Samarinda; KKR: Kutai Kartanegara; BPN: Balikpapan; KTM: Kutai Timur; PSR: Paser; PPU: Penajam Paser Utara.

Species composition and handling demand

Large ruminants made up 67.2% of animals (749 of 1,115). Species mix differed among regions ($\chi^2 = 28.8$, $df = 4$, $P < 0.001$), though the effect was small (Cramér's $V = 0.16$) (Table 2). Balikpapan (adjusted residual for goats +3.13) and Kutai Timur (+2.76) handled more goats than expected, while Paser and Penajam Paser Utara combined handled more cattle (+3.33). In Kutai Timur, goats equalled cattle, whereas in Penajam Paser Utara there were 14 cattle for every goat. Per site, Penajam Paser Utara and Balikpapan handled 14.0 and 10.3 large ruminants respectively, against 2.6 in Kutai Kartanegara (Figure 3).

Table 2. Species composition of sacrificial animals handled by DSH East Kalimantan by region, with adjusted standardised residuals from the region $\times$ species test

Region	Cattle/buffalo (n)	Goats (n)	Cattle share (%)	Goats per cattle	Cattle per site	Adj. residual (goats)
Samarinda City	509	230	68.9	0.45	4.59	-1.70
Kutai Kartanegara Regency	65	23	73.9	0.35	2.60	-1.39
Balikpapan City	113	83	57.7	0.73	10.27	+3.13b
Kutai Timur Regency	27	27	50.0	1.00	5.40	+2.76b
Paser + Penajam Paser Utaraa	35	3	92.1	0.09	8.75	-3.33b
Total	749	366	67.2	0.49	4.80	

Note: $\chi^2 = 28.75$, $df = 4$, $P < 0.001$; Cramér's $V = 0.16$. ^aMerged for the test because Paser had an expected goat count < 5 (Paser: 7 cattle, 1 goat; Penajam Paser Utara: 28 cattle, 2 goats). ^b|r| > 1.96 . Residuals for cattle are equal in magnitude and opposite in sign.

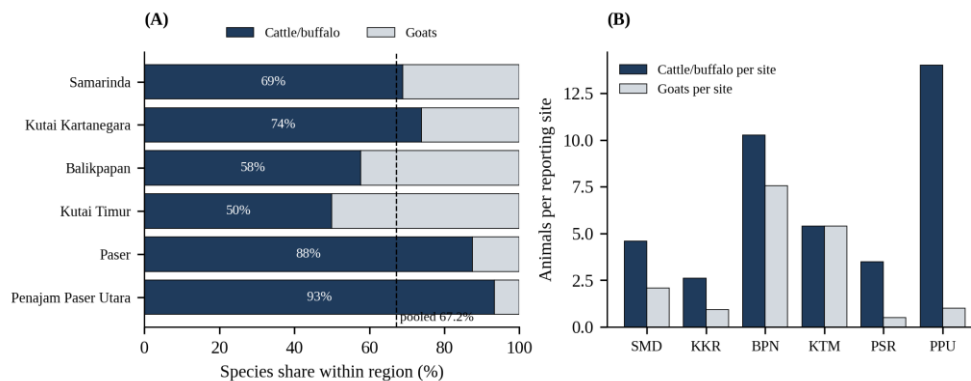


Figure 3. Species composition of assisted slaughter. A. Share of cattle/buffalo and goats within each region; the dashed line marks the pooled cattle share. B. Mean number of cattle/buffalo and goats per reporting site.

Allocation of trained personnel across slaughter stages

Task categories were unevenly distributed ($\chi^2 = 73.9$, $df = 4$, $P < 0.001$). Casting and slaughter was the most common category (35.9%), followed by slaughter only (30.1%) and complete coverage (26.9%) (Table 3; Figure 4A). Categories that included skinning without casting were rare (7.0% combined). At the stage level, DSH personnel performed the neck cut at 97.4% of sites, casting at 62.8%, and skinning at 34.0% (Figure 4B). Among the 67 sites where DSH covered only one of casting and skinning, 56 involved casting without skinning and 11 involved skinning without casting (exact binomial $P < 0.001$). DSH deployed 743 personnel, an average of 4.8 per site and 1.5 animals per person.

Table 3. Tasks performed by DSH officers at reporting sites ($n = 156$) and derived coverage of slaughter stages

Task category	Sites (n)	Sites (%)	95% CI (Wilson)	Casting	Neck cut	Skinning
Casting and slaughter	56	35.90	28.8-43.7	✓	✓	
Slaughter only	47	30.13	23.5-37.7		✓	
Complete (casting, slaughter, skinning)	42	26.92	20.6-34.4	✓	✓	✓
Slaughter and skinning	7	4.49	2.2-9.0		✓	✓
Skinning only	4	2.56	1.0-6.4			✓
Stage coverage, n (%)				98 (62.8)	152 (97.4)	53 (34.0)
95% CI of stage coverage				55.0-70.0	93.6-99.0	27.0-41.7

Note: Goodness-of-fit against a uniform distribution of task categories: $\chi^2 = 73.9$, $df = 4$, $P < 0.001$. Discordant sites (casting without skinning, $n = 56$, versus skinning without casting, $n = 11$): exact binomial $P < 0.001$. Personnel: 743 in total, 4.76 per site, 1.50 animals per person.

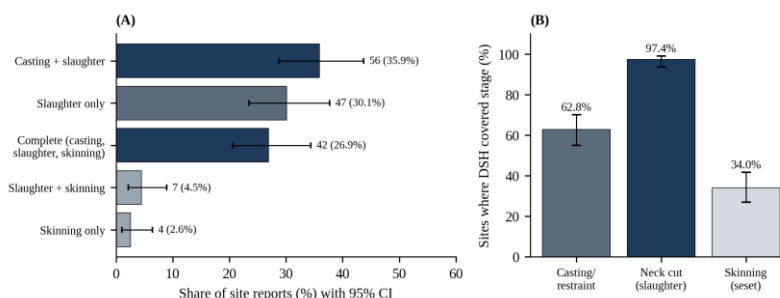


Figure 4. Deployment of DSH personnel. A. Distribution of task categories across 156 site reports with Wilson 95% CI. B. Proportion of sites at which DSH personnel covered casting, the neck cut and skinning.

Field constraints viewed through a welfare framework

Table 4 codes the eight constraints reported by officers. Five of the eight concern people and organisation rather than animals or equipment: skill shortage for skinning (C1), non-uniform casting technique (C2), divergent technical understanding between DSH and local committees (C3), weak committee discipline and coordination (C6), and limited public understanding of halal and welfare standards (C7). Two concern the physical setting (C4, C8), and one concerns the animal (C5).

Table 4. Constraints reported by DSH officers, in descending order of reported frequency, coded to the Five Domains model and operational dimensions

Code	Constraint reported	Operational dimension	Five Domains link	Welfare or safety mechanism (supporting evidence)
C1	Shortage of skilled personnel for skinning (seset)	Human-resource capacity	Mental state (indirect); health	Pressure to begin dressing before death is confirmed; hand injuries in untrained helpers (EFSA 2020; Oktay et al. 2021)
C2	Non-uniform casting technique across committees	Human-resource capacity; standards	Health; behavioural interactions; mental state	Falls, repeated attempts and bruising during rope casting (Grandin 1997; Wibowo et al. 2024)
C3	Divergent technical understanding between DSH and local committees	Governance; knowledge	Behavioural interactions	Conflicting instructions during restraint; inconsistent head positioning at the cut (Velarde et al. 2014)
C4	Cramped or unsuitable site	Infrastructure	Physical environment; health	Slipping on wet or uneven floors; animals waiting in view of slaughter (Terlouw et al. 2008; WOAHA 2023)
C5	Aggressive or hard-to-cast animals	Animal factor interacting with handling	Behavioural interactions; mental state	Fear-related struggling amplified by shouting, pulling and crowding (Hemsworth 2003; Grandin 2021)
C6	Weak discipline and coordination among committee members	Governance and coordination	Behavioural interactions	Crowding of spectators and helpers around the animal; unclear command at the cut
C7	Limited public understanding of halal and animal welfare standards	Knowledge and culture	Mental state (indirect)	Social pressure to speed up, film or intervene; tolerance of rough handling (Jalil et al. 2018)
C8	Limited supporting equipment at some sites	Infrastructure and equipment	Health; mental state	Blunt knives, weak ropes, no hoist; incomplete cuts and false aneurysm (Gregory et al. 2008; Farouk 2013)

Note: The report ranked constraints by frequency of mention without giving counts; rank is therefore ordinal. Five Domains links follow Mellor (2017) and Mellor et al. (2020); Domain 1 (nutrition: feed and water before slaughter) was not referred to in any report.

Field solutions and the fit between constraints and responses

Officers reported eight field solutions: active coordination with the local committee (S1), clearer task division (S2), teamwork and gotong royong (mutual aid) (S3), direct mentoring by a more experienced slaughterer (S4), use of casting and slaughter techniques taught in DSH training (S5), casting adapted to site conditions (S6), borrowing and making the best use of available equipment (S7), and briefing the committee before slaughter (S8). The constraint-solution matrix (Figure 6) shows that C2 and C5 received the most direct responses, mainly through technical measures (S4-S6). C4 (site) and C7 (public literacy) received only one direct response each, and C8 (equipment) was addressed only by borrowing, which does not solve the underlying shortage.

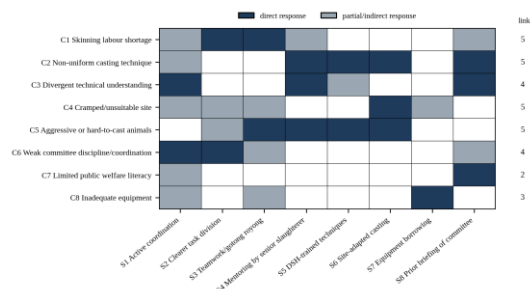


Figure 6. Constraint-solution matrix derived from DSH officer reports. Cells show whether a field solution (columns) responds directly (dark), partially or indirectly (grey), or not at all (white) to a reported constraint (rows). The right-hand column gives the number of solutions linked to each constraint. Scoring was performed by the authors.

Table 5. Suggestions from DSH officers to local committees (G) and to DSH East Kalimantan (H), linked to the constraints they address and translated into priority actions

Code	Suggestion reported by officers	Constraints addressed	Priority action proposed by the authors
G1	Improve committee discipline and coordination	C3, C6	Appoint one site coordinator; limit people in the slaughter area to the casting crew and slaughterer
G2	Increase education on halal slaughter	C3, C7	Pre-Eid briefing for committees using a short illustrated guide framed around ihsan
G3	Improve task division on the day	C1, C6	Written task roster by stage (handling, casting, cut, death check, skinning)
G4	Prepare adequate casting and skinning personnel	C1, C2	Match crew size to planned number of cattle; register skinners in advance
G5	Ensure equipment is available and ready	C8	Minimum kit: two or more sharp knives per slaughterer, whetstone and steel, tested ropes, non-slip flooring, screen, hoist or frame
H1	Continuous coaching for new members	C2, C3	Mentored first deployment, pairing each new member with a senior slaughterer
H2	Strengthen the regional network of halal slaughterers	C1, C4	Train instructors in Kutai Kartanegara, Balikpapan and Penajam Paser Utara, where loads per site were extreme
H3, H7	Develop uniform operating standards and minimum site requirements	C2, C4, C8	Standard casting protocol and a site pre-assessment checklist completed before Eid
H4	Develop certification and competency programmes	C1, C2	Separate competency tracks for casting and skinning within SKKNI-based certification
H5, H6	Regular advanced training; more instructors and trained members	C1, C2, C5	Annual refresher with low-stress handling and rope-casting practice
H8	Expand public education on halal slaughter	C7	Friday sermon material and social media content before Eid
(none)	(not suggested by officers)	All	Add animal-based indicators to the post-event form: falls, vocalisation, repeat cuts, time to collapse, dressing before death

Note: Codes G1–G5 and H1–H8 follow the numbering in the source report (DSH Kaltim 2026). Priority actions are the authors' synthesis and were not part of the officer reports.

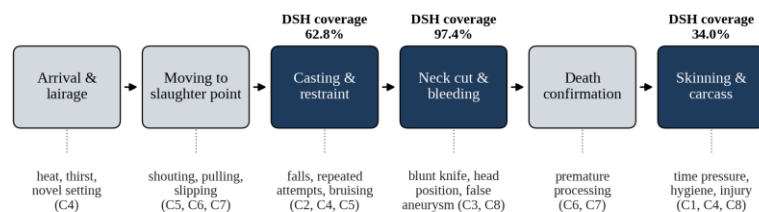
4. Discussion

Spatial distribution and species-related workload

DSH services showed two patterns: Samarinda and Kutai Kartanegara had more sites with smaller loads, while Balikpapan and Penajam Paser Utara had fewer but higher-load sites. High workloads may increase waiting time, handling difficulty, and welfare risks when staff and facilities are limited (Nakyinsige et al., 2013; WOA, 2023; Grandin, 2021). Species composition also affected workload. Cattle weighing 300–500 kg require more controlled casting than goats, making falls, slipping, and struggling important welfare concerns. Wibowo et al. (2024) reported falls or slips in more than one-third of cattle at Samarinda mosques. Therefore, team size should consider both animal number and species.

Coverage of critical slaughter stages

DSH involvement was highest for the neck cut, reflecting religious and competency requirements (MUI, 2009; Kemnaker, 2014). However, casting is also critical because poor restraint can cause injury and prolong distress (Velarde et al., 2014; EFSA, 2020). DSH personnel did not perform casting at 37.2% of sites.



Dark boxes: stages for which DSH task categories were recorded. Grey boxes: stages not captured by the reporting form. Codes C1–C8 refer to the constraints in Table 4.

Figure 5. Stages of community sacrificial slaughter, the principal welfare and safety risks at each stage, and the proportion of sites at which DSH personnel covered the stage. Risks are drawn from Gregory et al. (2008, 2010), Wibowo et al. (2024) and EFSA (2020); constraint codes refer to Table 4.

Skinning had the lowest DSH coverage and was the leading reported constraint. Limited skinners may delay processing and create pressure to begin dressing before death is confirmed, contrary to WOAHA (2023) and EFSA (2020). It may also increase worker injury risks, as most Eid-related injuries in one study involved non-professionals during meat processing (Oktay et al., 2021). The average of 4.8 personnel per site suggests that the main limitation was skill composition rather than personnel numbers, with teams dominated by slaughterers and casters (Sinclair et al., 2017; Erian et al., 2019).

Welfare implications of field constraints

Poor handling can affect both welfare and meat quality by increasing stress, ultimate pH, bruising, and carcass losses (Terlouw et al., 2008; Farouk et al., 2014). Crowds, noise, tethering, and unfamiliar environments may further increase animal fear and handling difficulty (Grandin, 2021). Standardised casting and crowd control could therefore reduce these risks. Differences between traditional practices and trained personnel may also affect compliance. Previous studies suggest that religious values and peer influence shape perceptions of halal slaughter welfare (Sinclair et al., 2017; Jalil et al., 2018). Most field responses relied on gotong royong and same-day improvisation, but prior training and preparation are needed to address shortages in skills and facilities (Pretty, 2003; Coleman & Hemsworth, 2014).

Comparison with previous studies

Previous studies identified restraint, pre-slaughter handling, and untrained personnel as important welfare and safety concerns (Velarde et al., 2014; Wibowo et al., 2024; Oktay et al., 2021; Tapan et al., 2024). The present study adds a provincial perspective, showing that trained personnel were least available for casting and skinning, the stages surrounding the neck cut.

Table 6. Comparison of the present study with published studies of sacrificial and religious slaughter

Study	Setting and sample	Design and measures	Main findings relevant to this study
Velarde et al. (2014)	Abattoirs in selected European countries (DIALREL project); cattle, sheep, goats, poultry	Observational assessment of restraint, neck cut, bleeding and post-cut handling	Wide variation in restraint and cut practice between plants; restraint identified as a key welfare hazard
Safitri et al. (2022)	Banyumas, Central Java; 4 pesantren and 4 city mosques; 60 animals	Five-point scoring of transport, shelter, preparation, slaughter and post-slaughter	Slaughter scored 77.2% at pesantren vs 67.3% at city mosques; transport scored lowest at both
Wibowo et al. (2024)	Samarinda, East Kalimantan; 9 mosques; 115 cattle	Animal-based indicators during handling and slaughter	Falls/slips 36.52%; vocalisation 15.65%; longest time to death 10-12 min
Oktay et al. (2021)	Gaziantep, Türkiye; 5 emergency departments; 277 patients	Prospective cohort of sacrifice-related injuries	91% of injured were non-professionals; hands most affected (78.7%)
Tapan et al. (2024)	Ankara, Türkiye; 610 patients, 2019-2023	Retrospective single-centre series	Hand and maxillofacial injuries recur every Eid; calls for training and protective measures
Present study	East Kalimantan; 156 sites; 1,115 animals; 743 personnel	Cross-sectional analysis of officer reports; stage coverage; constraint coding	Neck cut covered at 97.4% of sites, casting 62.8%, skinning 34.0%; skinner shortage ranked first among constraints

Implications for community-based slaughter programmes

Three priorities emerge: (1) provide dedicated casting training and a standard protocol; (2) establish separate recruitment and training for skinners; and (3) allocate personnel according to animal load rather than site number. High-load sites require greater casting capacity. The reporting system should also include animal-based indicators such as falls, vocalisation, number of cuts, time to collapse, and dressing before death. These measures could support welfare monitoring across Eid seasons and build on existing Samarinda observations (Wibowo et al., 2024).

5. Conclusion

This study was limited by aggregated organisational data, unavailable site-level records, ordinal constraint rankings, and the absence of animal-based welfare and injury data. The sample also represented only sites requesting DSH assistance. Future studies should collect standardised site-level data, combine reports with direct observations, and monitor sites across multiple Eid seasons.

Overall, DSH East Kalimantan assisted 156 sites and 1,115 animals during Eid al-Adha 1447 H. While trained personnel covered the neck cut at most sites, coverage was lower for casting and skinning. Skinner shortages and non-uniform casting were the main constraints. Priority improvements include a standardised casting protocol, dedicated skinner training, load-based personnel deployment, and animal-based welfare indicators in routine reporting.

Acknowledgements

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