Original Article

Nurse Competence, Work Environment, and Patient Safety: The Mediating Role of Bedside Handover in Indonesia: A Cross-Sectional Study

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ABSTRACT

Background: Patient safety remains a major global concern, especially in low- and middle-income countries (LMICs) where resource limitations and communication gaps contribute to preventable harm. Although bedside handover is recognized as a strategy to enhance transparency and safety culture, few studies have examined its mediating role between nurse competence, work environment, and patient safety.

Methods: This cross-sectional study, conducted in accordance with STROBE guidelines, involved 258 inpatient nurses selected through proportionate stratified random sampling from four hospitals in North Sulawesi, Indonesia. Eligible participants had at least one year of experience and were actively involved in bedside handover. Validated instruments the Nurse Competence Scale (NCS), Area of Worklife Survey (AWS), Nursing Handoff Competency Scale (NHCS), and Safety Care Activity Scale (SCAS), were used. Structural Equation Modeling with Partial Least Squares assessed measurement validity and structural relationships.

Results: All instruments met recommended validity and reliability standards, and the sample primarily comprised early-career female nurses. Structural modeling showed that both nurse competence and the work environment were positively associated with bedside handover, which in turn demonstrated a strong relationship with patient safety. Bedside handover partially mediated the influence of nurse competence and fully mediated the influence of the work environment on patient safety.

Conclusion: Bedside handover serves as a central mechanism linking individual capabilities and organizational conditions to safer patient outcomes. Strengthening competency development, promoting fairness and teamwork, and standardizing bedside handover practices may offer practical, low-cost pathways to improve patient safety in LMIC contexts

Keywords: Patient Safety; Nurse Competence; Work Environment; Bedside Handover; Structural Equation Modeling; Nursing Communication; LMIC Health Systems.

Implications for Practice:

- Strengthen clinical competence and leadership by integrating continuous training in clinical judgment, therapeutic communication, and transformational leadership to ensure nurses can deliver clear and patient-centered bedside handovers, especially in resource-limited LMIC settings.

Implications for Practice:

- Standardize bedside handover procedures through the use of unit-specific checklists, SBAR-based scripts, and structured patient-family engagement steps to reduce communication errors and enhance consistency in daily practice.
- Promote fair and supportive work

Implications for Practice:

environments by improving workload equity, ensuring transparent promotion and incentive systems, and fostering a positive team climate so that nurses remain engaged and able to perform bedside handover reliably as part of hospital safety policy

Introduction

Patient safety is a central indicator of healthcare quality worldwide and remains a persistent challenge in both high-income countries (HICs) and low- and middle-income countries (LMICs). Globally, one in ten patients experiences harm during hospitalization, and nearly 50% of these events are preventable through systematic safety practices (OECD, 2022; World Health Organization, 2023). The burden is even greater in LMICs, where resource limitations, workforce shortages, and weak safety infrastructures contribute to higher rates of adverse events. In Indonesia, patient safety implementation is regulated through the Minister of Health Regulation No. 11/2017, which emphasizes risk identification, effective communication, and incident reporting. However, despite this regulatory framework, hospitals continue to face substantial barriers, including limited resources, inadequate communication, and a low reporting culture (Mudayana et al., 2019; Ningsih & Endang Marlina, 2020). These challenges create a persistent gap between policy expectations and actual safety practices.

Nurse competence is fundamental to achieving patient safety outcomes. The International Council of Nurses defines nurse competence as the integration of knowledge, skills, and professional behaviors needed to deliver safe and high-quality care (ICN, 2025). Studies consistently show that higher nurse competence is associated with reduced medical errors, improved clinical judgment, and greater patient satisfaction (Tai et al., 2024; Zaitoun et al., 2023). At the same time, the work environment significantly influences safety culture. Poor working conditions, such as heavy workloads, staff shortages, and inadequate facilities, increase the risk of clinical errors (Maghsoud et al., 2022). Positive environments, in contrast, are linked to lower mortality, improved nurse performance, and higher patient satisfaction (Brooks Carthon et al., 2021).

Communication plays a crucial role in linking these factors to patient safety. Bedside handover, where nurses transfer patient information directly at the bedside with involvement from patients and families, has been shown to enhance transparency, accountability, and communication accuracy. Evidence indicates that structured bedside handover can reduce communication-related errors by up to 30%, increase patient satisfaction, and strengthen safety culture (Cruchinho et al., 2023; Desmedt et al., 2021; Do & Shin, 2024). However, previous studies have examined nurse competence, work environment, and patient safety mostly as separate factors, and very few have investigated how bedside handover may serve as a mediating communication mechanism within this relationship. This gap is particularly evident in LMIC settings, where communication practices and work environment conditions differ substantially from HIC contexts.

To guide the present study, the Socio-Technical Systems Theory is used as the conceptual framework. This theory emphasizes that patient safety emerges from the interaction between human competence, organizational conditions, and communication processes. In this study, nurse competence represents the human (social) subsystem, the work environment reflects the organizational subsystem, and bedside handover represents the communication process that connects these

subsystems to the outcome of interest, namely patient safety. Based on this framework, nurse competence and work environment are expected to have direct positive effects on patient safety, as well as indirect effects through their influence on the quality of bedside handover. Accordingly, the study proposes that: (H1) higher nurse competence is associated with better patient safety; (H2) a more favorable work environment is associated with better patient safety; (H3) higher nurse competence is associated with better implementation of bedside handover; (H4) a more favorable work environment is associated with better implementation of bedside handover; (H5) better implementation of bedside handover is associated with better patient safety; and (H6–H7) bedside handover mediates the relationships between nurse competence, work environment, and patient safety. However, despite evidence on the individual effects of competence, work environment, and bedside handover, no previous research has integrated these variables into a single structural model nor tested bedside handover as a mediator, especially within the Indonesian hospital context. This creates a clear research gap that warrants further empirical investigation. Therefore, the purpose of this study is to develop and test a nursing management model that integrates nurse competence, work environment, and bedside handover to improve patient safety. Specifically, this study aims to examine whether bedside handover mediates the relationship between nurse competence, work environment, and patient safety among inpatient nurses in Indonesia. The findings are expected to offer both theoretical contributions to communication-based patient safety models and practical recommendations for strengthening safety culture in hospitals.

Methods

Study Design

This study employed a quantitative cross-sectional design to examine the relationships among nurse competence, work environment, bedside handover, and patient safety. All variables were measured at a single point in time using standardized self-report instruments (Agnesia et al., 2023; Liberty, 2024). The study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. It was guided by a conceptual model based on Socio-Technical Systems Theory, which posits that human factors (competence), organizational factors (work environment), and communication processes (bedside handover) interact to influence patient safety outcomes. Data were collected between August and October 2025 across four hospitals in North Sulawesi Province, Indonesia

Participants

The study was conducted in four hospitals in Indonesia: Sam Ratulangi Tondano Indonesia Hospital, Anugerah Tomohon Indonesia Hospital, GMIM Bethesda Tomohon Indonesia Hospital, and Siloam Sonder Indonesia Hospital. The target population consisted of 721 inpatient nurses working in medical-surgical, pediatric, maternity, and ICU wards.

A proportionate stratified random sampling technique was used. Strata were formed based on four hospitals and the inpatient unit type within each hospital. The proportion of participants from each stratum matched the composition of the overall nurse population.

A sample size of 258 nurses was determined using Slovin's formula (e = 0.05). A priori power analysis was not performed due to the absence of previous effect size estimates in the local context; thus, Slovin's method was considered

appropriate for representativeness. The inclusion criteria were nurses with ≥1 year of clinical experience, nurses actively involved in bedside handover, and nurses willing to participate and provide informed consent. The exclusion criteria included nurses on extended leave during data collection, nurses in administrative or non-clinical positions, and incomplete questionnaires (>10% missing responses).

Nurses were approached through ward managers. Of the 290 nurses invited, 258 completed the questionnaire (response rate: 89%). Non-responders cited workload or schedule constraints.

Instruments

All instruments underwent forward–backward translation (English → Bahasa Indonesia → English) by bilingual experts. A panel of three nursing scholars reviewed content validity. A pilot test with 30 nurses assessed clarity and reliability; no major modifications were required. Permissions were obtained for all standardized tools. Measurement scales are provided below:

Nurse Competence Scale (NCS)

The Nurse Competence Scale (NCS) assesses nursing competence across seven key dimensions using an interval scale ranging from 0 to 100. The instrument evaluates areas such as Nursing Care, Value-based Nursing Care, Medical and Technical Care, Care Pedagogics, Documentation and Administration, Development, and Leadership and Organization. Mean scores are calculated to determine overall competence, with higher scores indicating stronger nursing skills. The tool demonstrates good reliability, with Cronbach's alpha values ranging from 0.70 to 0.89 (Nilsson et al., 2018).

Area of Worklife Survey (AWS)

The Area of Worklife Survey (AWS) consists of 27 items measured on a 5-point Likert scale from strongly disagree (1) to strongly agree (5). Total scores range from 27 to 135 and classify the work environment into three levels: poor (27–67), moderate (68–101), and good (102–135) (Maslach et al., 2001). The survey evaluates six dimensions: Workload, Control, Reward, Community, Fairness, and Values and has demonstrated strong reliability, with reported Cronbach's alpha values above 0.70 (Chudzicka-Czupała et al., 2022).

Nursing Handoff Competency Scale (NHCS)

The Nursing Handoff Competency Scale (NHCS) includes 25 items scored on a 4-point Likert scale to measure nurses' competency in conducting bedside handovers. Total scores range from 25 to 100, with values below 60 indicating low competency, 60–79 representing moderate competency, and scores of 80 or higher reflecting high competency. The scale encompasses three dimensions: Patient Identification, Assessment and Nursing Situation Transfer, and Therapeutic Relationship Building and has excellent reliability with a Cronbach's alpha of 0.91 (Do & Shin, 2024).

Safety Care Activity Scale (SCAS)

The Safety Care Activity Scale (SCAS) consists of 34 items measured using an interval scale to assess the extent of patient safety practices performed by nurses. Scores range from 34 to 136, where higher values indicate stronger implementation of safety care activities. The instrument covers seven dimensions, including Patient Identification, Medication Safety, Blood Transfusion Safety, Infection Control, Fall and Injury Prevention, and Fire Safety. The SCAS demonstrates exceptional reliability, with a Cronbach's alpha of 0.96 (Yang, 2021).

Data Collection

Data were collected by the primary researcher with three trained enumerators from 1 September to 1 October 2025. Administrative approval was obtained from hospital management and the nursing division, and unit coordinators identified eligible nurses. Enumerators received a 2–3 hour training on study objectives, eligibility, informed consent, questionnaire administration, and handling queries, including role-plays and a pilot test; competency was validated through observation and a brief checklist. During data collection, informed consent was obtained, and paper-based questionnaires were distributed during break periods, completed independently, and returned in sealed envelopes to a collection box. Questionnaires were coded, double-entered into a password-protected database, and cross-checked; cases with >10% missing responses were excluded, and missing data were minimal (<2%), so no imputation was required. Databases were stored in encrypted files, paper forms in a locked cabinet, and only de-identified data were analyzed in line with hospital data protection policies and ethics requirements.

Data Analysis

Data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) in SmartPLS Version 4.0. The rationale for using PLS-SEM included its suitability for complex models with multiple latent variables and mediation pathways, its requirement for fewer assumptions regarding multivariate normality, and its appropriateness for predictive modeling and examining exploratory relationships.

Pre-analysis checks were conducted prior to model estimation. Normality was assessed descriptively, although PLS-SEM does not require normally distributed data. Multicollinearity was evaluated using Variance Inflation Factors (VIF). A threshold of VIF < 3.3 was applied, as values below this cut-off indicate the absence of problematic collinearity and reduce the risk of inflated standard errors and unstable path estimates.

The outer model (measurement model) was evaluated by assessing convergent validity using the Average Variance Extracted (AVE ≥ 0.50), discriminant validity using the Fornell–Larcker criterion and cross-loadings, and reliability using Composite Reliability (CR) and Cronbach's α (≥ 0.70).

The inner model (structural model) was then evaluated. The coefficient of determination (R^2) was used to assess explanatory power. Path coefficients (β) were estimated for the hypothesized relationships. Effect sizes (f^2) were calculated to evaluate the impact of exogenous variables. Bootstrapping with 5000 resamples was used to obtain standard errors and test significance, and a significance level of $p < 0.05$ was applied. Mediation was assessed using the Variance Accounted For (VAF), calculated as the ratio of the indirect effect to the total effect, where the indirect effect is the product of the paths through the mediator and the total effect is the sum of the direct and indirect effects. VAF values between 20–80% were interpreted as partial mediation, values ≥ 80% as full mediation, and values < 20% as indicating no meaningful mediation.

$$\text{VAF} = \frac{\text{indirect effect}}{\text{total effect}} \times 100\%$$

Ethical Considerations

This study was reviewed and approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Brawijaya, Malang (Ethics approval number: 203/UN10.F17.10.4/TU/2025). It was conducted in accordance with the Declaration of Helsinki. All participants

received a written information sheet and provided written informed consent before data collection. Participation was entirely voluntary, with no coercion or penalty for refusal or withdrawal. Anonymity was ensured by assigning each participant a unique identification code; no names or personal identifiers were entered into the dataset. Consent forms were stored separately from questionnaires to prevent linkage. Paper-based data were kept in a locked cabinet, and electronic data were stored in encrypted, password-protected files accessible only to the research team. As all participants were legally competent adult nurses, guardian consent was not required, and no waiver of consent was applied.

Results

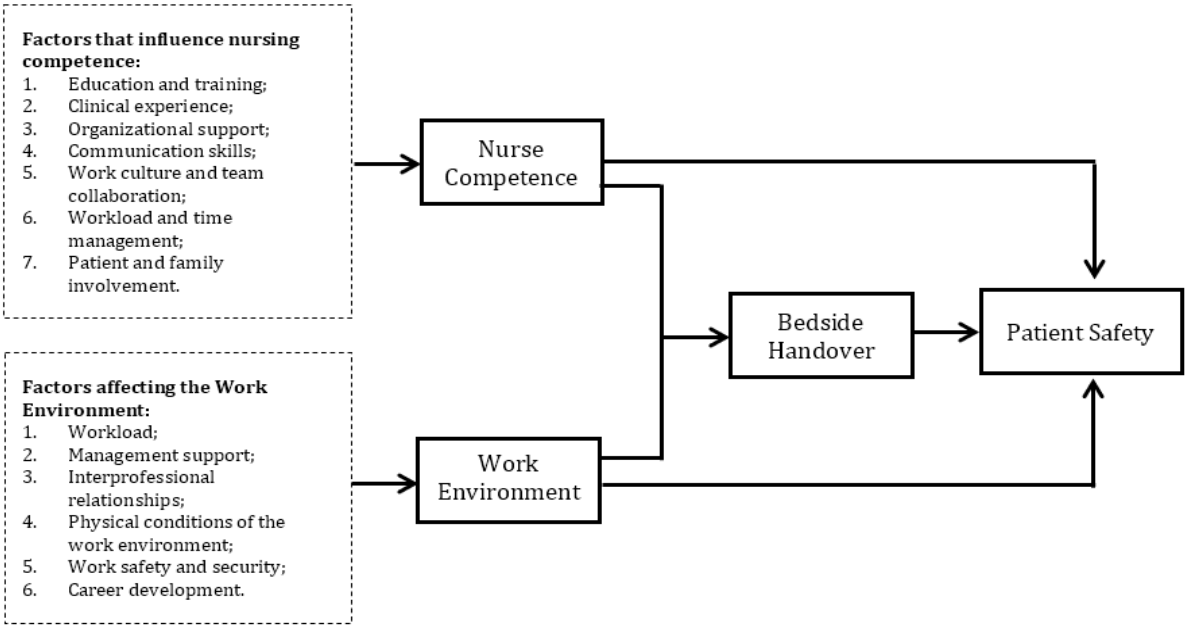

Figure 1. Conceptual Framework

Figure 1 presents the conceptual framework illustrating how nurse competence and the work environment influence patient safety, both directly and through the mediating role of bedside handover. Nurse competence is shaped by factors such as education, clinical experience, organizational support, communication skills, teamwork and work culture, time management, and patient–family involvement. Meanwhile, the work environment is influenced by workload, management support, interprofessional relationships, physical conditions, workplace safety, and career development. Both constructs interact to strengthen the quality of bedside handover, ultimately contributing to improved patient safety.

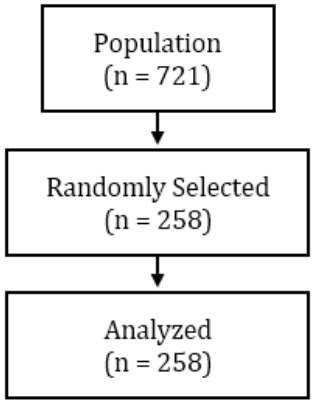

Figure 2. STROBE Sampling Flow Diagram

Figure 2 depicts the sampling process following the STROBE guidelines, beginning with an initial population of 721 individuals. From this population, 258 participants were randomly selected to be included in the study. All selected participants were then analyzed, resulting in a final sample size of 258, demonstrating a clear, systematic, and transparent sampling procedure.

Conceptual Model Diagram

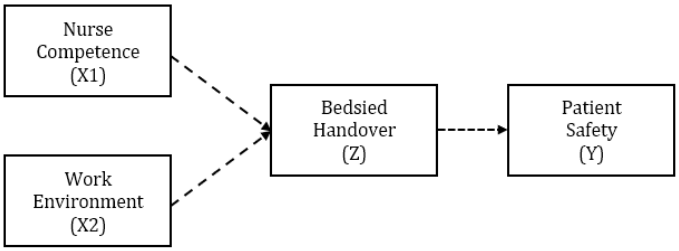

Figure 3. Conceptual Model Diagram (ASCII Version)

Figure 3 provides an ASCII-style conceptual model that illustrates the relationships between nurse competence (X1) and the work environment (X2) on patient safety (Y) through the mediating variable of bedside handover (Z). The diagram shows that both independent variables exert indirect effects on patient safety by enhancing the quality of bedside handover, emphasizing its role as a critical process in ensuring safe and effective patient care.

Table 1. Frequency Distribution of Respondent Characteristics (n = 258)

Characteristics	Group	Frequency (n)	Percentage (%)
Gender (Sex)	Female	213	78,60
	Male	45	17,40
Age (Year)	< 25	35	13,8
	26-35	143	55,6
	> 35	80	30,6
Education Level	Diploma III in Nursing	170	65,90
	Bachelor of Science in Nursing	88	34,10
Work Experience	< 5 years	130	50,40
	5-10 years	75	29,10
	> 10 years	53	20,59
Hospital	Sam Ratulangi Tondano	85	32,90
	GMIM Bethesda Tomohon	84	32,60
	Anugerah Tomohon	44	17,10
	GMIM Siloam Sonder	45	17,40

Based on **Table 1,** it shows the characteristics of the 258 participating nurses are presented in Table 1. Most respondents were female (n = 213; 78.60%), while 45 (17.40%) were male. The majority were aged 26–35 years (n = 143; 55.6%), followed by those aged >35 years (n = 80; 30.6%), and <25 years (n = 35; 13.8%).

In terms of education, most nurses held a Diploma III in Nursing (n = 170; 65.9%), while 88 (34.1%) had a Bachelor of Science in Nursing (Ners) degree. Regarding work experience, half of the respondents had <5 years of experience (n = 130; 50.4%), 75 nurses (29.1%) had 5–10 years of experience, and 53 nurses (20.6%) had >10 years of experience. The distribution by hospital was relatively balanced, with 85 nurses (32.9%) from Sam Ratulangi Tondano Hospital, 84 (32.6%) from GMIM Bethesda Tomohon Hospital, 44 (17.1%) from Anugerah Tomohon Hospital, and 45 (17.4%) from GMIM Siloam Sonder Hospital.

Table 2. Convergent Validity Score

Variable	Indicator	Loading Factor	Description
Nurse Competence	NC1	0.867	Strong enough
	NC2	0.871	Strong enough
	NC3	0.856	Strong enough
	NC4	0.936	Very strong
	NC5	0.703	Strong enough
	NC6	0.703	Strong enough
Work Environment	WE1	0.360	Weak
	WE2	0.730	Strong enough
	WE3	0.706	Strong enough
	WE4	-0.817	Strong enough (Negative Direction)
	WE5	0.599	Somewhat Weak
	WE6	0.661	Quite Strong
Bedside Handover	BH1	0.935	Very Strong
	BH2	0.957	Very Strong
	BH3	0.911	Very Strong
	BH4	0.928	Very Strong
Patient Safety	PS1	0.887	Quite Strong
	PS2	0.924	Very Strong
	PS3	0.930	Very Strong
	PS4	0.927	Very Strong
	PS5	0.939	Very Strong
	PS6	0.828	Quite Strong

Outer loading = standardized correlation of indicators with constructs; values ≥0.70 generally indicate that the indicators represent the constructs well.

Table 3. Loading Factor Score

Variable	Indicator	Loading Factor	Description
Nurse Competence	NC1	0.867	Strong Enough
	NC2	0.871	Strong Enough
	NC3	0.856	Strong Enough
	NC4	0.936	Very Strong
	NC5	0.925	Very Strong
	NC6	0.703	Strong Enough
Work Environment	WE2	0.743	Strong Enough
	WE3	0.722	Strong Enough
	WE4	0.882	Very Strong
Bedside Handover	BH1	0.935	Very Strong
	BH2	0.957	Very Strong
	BH3	0.911	Very Strong
	BH4	0.928	Strong Enough
Patient Safety	PS1	0.887	Very Strong
	PS2	0.924	Very Strong

Variable	Indicator	Loading Factor	Description
	PS3	0.930	Very Strong
	PS4	0.927	Very Strong
	PS5	0.929	Strong Enough
	PS6	0.829	Strong Enough

Loading factor (outer loading) represents the standardized correlation between each indicator and its latent construct; values ≥ 0.70 generally indicate that the indicator adequately represents the construct and supports convergent validity.

Table 2. Univariate Analysis Results

Variable	Indicator	Mean	Category	Interpretation
Nurse Competence (X1)	Nursing Care (X1.1)	3,24	Good	Care provided according to standards
	Value-Based Nursing Care (X1.2)	3,36	Good	High ethical values applied
	Medical and Technical (X1.3)	3,10	Fair	Technical skills need improvement
	Pedagogical Care (X1.4)	3,29	Good	Patient education is quite effective
	Documentation and Administration (X1.5)	3,25	Good	Documentation is well-maintained
	Development and Leadership (X1.6)	2,95	Fair	Leadership and initiative are still low
Work Environment (X2)	Workload (X2.1)	3,61	Good	Reasonable workload
	Control (X2.2)	3,63	Good	High level of control
	Recognition (X2.3)	3,60	Good	Good recognition from superiors
	Community (X2.4)	3,99	Very good	Strong team relationships
	Fairness (X2.5)	3,21	Fair	Organizational fairness needs improvement
	Values (X2.6)	3,42	Good	Good understanding of procedures
Bedside Handover (Z)	Knowledge Handover Methods (Z1)	3,40	Good	Good understanding of procedures
	Patient Information Identification (Z2)	3,35	Good	Effective data exchange
	Assessment and Transfer of Situation (Z3)	3,28	Fair	Clinical analysis aspects need strengthening
	Mutually Supportive Relationships (Z4)	3,38	Good	Positive interpersonal communication
Patient Safety (Y)	Patient Identification (Y1)	3,49	Good	Identification procedures are running well
	Medication (Y2)	3,55	Very good	Medication administration is safe and accurate
	Blood Transfusion (Y3)	3,44	Good	Transfusion procedures are safe
	Infection Management (Y4)	3,53	Very good	Infection prevention is effective
	Fall and Injury Management (Y5)	3,46	Good	Injury prevention is adequate
	Fire Management (Y5)	3,37	Good	Preparedness needs further training

Mean calculated from a 1–4 Likert scale (1 = poor, 2 = fair, 3 = good, 4 = excellent); "Category" and "Interpretation" describe the descriptive assessment of each dimension.

Based on **Table 2**, the descriptive statistics for nurse competence, work environment, bedside handover, and patient safety are summarized in Table 2. Overall, most indicators were in the "good" category. For nurse competence, "Value-Based Nursing Care" (X1.2) had the highest mean score (3.36, "good"), indicating strong application of ethical values in practice. In contrast, "Development and Leadership"

(X1.6) had the lowest mean score (2.95, "fair"), suggesting that leadership, initiative, and involvement in development activities need strengthening. For the work environment, "Community" (X2.4) showed a "very good" mean score (3.99), reflecting strong interpersonal relationships and teamwork among nurses. "Workload" (X2.1; 3.61) and "Control" (X2.2; 3.63) were in the "good" category, indicating generally acceptable workload and perceived autonomy. However, "Fairness" (X2.5) scored lower (3.21, "fair"), signaling perceived inequities in organizational policies or resource distribution. Regarding bedside handover, "Knowledge of Handover Methods" (Z1) had the highest mean (3.40, "good"), indicating good understanding of standardized procedures. "Assessment and Transfer of Situation" (Z3) scored slightly lower (3.28, "fair"), suggesting that the clinical analysis and synthesis aspects of handover still require improvement. For patient safety, most indicators were rated "good" to "very good." "Medication" (Y2; 3.55) and "Infection Management" (Y4; 3.53) were in the "very good" category, reflecting strong safety practices in these domains. "Fire Management" (Y6; 3.37) showed the lowest mean within the domain ("good"), indicating that emergency preparedness and fire safety training could be further enhanced.

Table 3. Measurement Model Evaluation (Outer Model) Result

Evaluation Components	Statistical Index	Results	Criteria	Interpretation
Convergent Validity	Outer Loading	≥ 0,70 (valid)	≥ 0,70	Indicators represent constructs
AVE	AVE Value	bedside handover= 0,87 patient safety= 0,822 nurse competence= 0,745 work environment= 0,617	>0,50	All constructs are convergent valid
Discriminant Validity	Cross Loading&Fornell-Larcker	achieved	-	Unique and non-overlapping constructs
Reliability (Cronbach's Alpha)	α Value	bedside handover= 0,95 patient safety= 0,956 nurse competence= 0,93 work environment= 0,691	≥ 0,70	All are reliable, work environment is close to the limit
Composite Reliability	rho_c	bedside handover= 0,964 patient safety= 0,965 nurse competence= 0,946 work environment= 0,828	≥ 0,70	All constructs are reliable

AVE (Average Variance Extracted) shows the proportion of indicator variance explained by the construct (≥0.50 = good convergent validity). α (Cronbach's alpha) and CR (Composite Reliability) assess internal reliability (≥0.70 = reliable).

Based on **Table 3,** it shows all indicators demonstrated adequate convergent validity, with outer loadings ≥ 0.70 (not shown in table but available in the PLS output), and Average Variance Extracted (AVE) values > 0.50 for all constructs (bedside handover = 0.870; patient safety = 0.822; nurse competence = 0.745; work environment = 0.617), indicating that each construct explains more than half of the variance in its indicators. Discriminant validity was achieved based on both the Fornell–Larcker criterion and cross-loadings, demonstrating that each construct is empirically distinct. In

terms of reliability, Cronbach's alpha values were above 0.70 for bedside handover (0.95), patient safety (0.956), and nurse competence (0.93), while the work environment scale showed an alpha of 0.691, which is slightly below the conventional threshold but still close to acceptable. Composite reliability (CR) values were all >0.80, indicating good internal consistency across constructs.

Table 4. Structural Model Evaluation (Inner Model) Result

Evaluation Parameters	Statistical Values	Evaluation Criteria	Interpretation
Goodness of Fit (GoF)	SRMR=0.062 NFI=0.891 GoF=0.59	SRMR<0.10 NFI≈1 GoF>0.36	Strong model fit
R-Square (R^2)	Bedside Handover=0.398 Patient Safety =0.554	-	Model explains >50% of patient safety variance
Q^2Predictive Relevance	Bedside Handover=0.383 Patient Safety =0.300	>0	The predictive model is relevant.
Effect Size (f^2)	Bedside Handover→ Patient Safety =0.536 Nurse Competence→ Bedside Handover =0.232 Work Environment→ Bedside Handover =0.123	≥0.35 large ≥0.15 medium ≥0.02 small	Bedside handover has the strongest effect
Path Coefficient	Bedside Handover→ Patient Safety =0.63 Patient Safety →Bedside Handover=0.424 Work Environment → Bedside Handover =0.309	p<0.05 significant	All are significant except Work Environment → Patient Safety

SRMR (Standardized Root Mean Square Residual) and NFI (Normed Fit Index) assess model adequacy (SRMR is smaller and NFI is closer to 1 = good fit). R^2 indicates the proportion of variance explained, Q^2 indicates predictive relevance (>0), and f^2 is a measure of effect (small 0.02; medium 0.15; large 0.35). β is the standardized path coefficient; p < 0.05 = significant.

Based on Table 4, the overall model fit was acceptable, with SRMR = 0.062 (<0.10), NFI = 0.891 (close to 1), and GoF = 0.59, indicating a strong model fit. The R^2 for bedside handover (Z) was 0.398, indicating that nurse competence and work environment together explained 39.8% of the variance in bedside handover. The R^2 for patient safety (Y) was 0.554, meaning that bedside handover, nurse competence, and work environment jointly explained 55.4% of the variance in patient safety. The Q^2 predictive relevance values were >0 for both bedside handover (0.383) and patient safety (0.300), confirming that the model has meaningful predictive ability. The effect size (f^2) values indicated that bedside handover had a large effect on patient safety (f^2 = 0.536), while nurse competence and work environment had medium to small effects on bedside handover (f^2 = 0.232 and 0.123, respectively). The path coefficients showed that:

1. Nurse competence → Bedside handover was significant (β = 0.424, p < 0.001).
2. Work environment → Bedside handover was significant (β = 0.309, p < 0.001).
3. Bedside handover → Patient safety was significant (β = 0.630, p < 0.001).
4. The direct path work environment → patient safety was not significant (p > 0.05).

Table 5. Mediation Effect Analysis Test Results

Mediation Path	Path Coefficient (β)	T-Statistic	p-value	Significance	Type of Mediation	Interpretation
Nurse Competence → Bedside Handover → Patient Safety	0.267	6.019	0.000	Significant	Partial	Direct and indirect competencies.
Work Environment→ Bedside Handover → Patient Safety	0.194	5.035	0.000	Significant	Full	Work environment influences through Bedside Handover.

β = standardized path coefficient for indirect effects; t-statistic and p-value indicate significance (p < 0.05 = significant). VAF (Variance Accounted For) is used to determine the type of mediation (≈20–80% = partial mediation; ≥80% = full mediation).

Table 5 shows the indirect effect of nurse competence on patient safety via bedside handover was significant (β = 0.267, t = 6.019, p < 0.001), indicating partial mediation, because nurse competence also has a direct effect on patient safety. For the work environment, the indirect effect on patient safety through bedside handover was also significant (β = 0.194, t = 5.035, p < 0.001). Given that the direct path from work environment to patient safety was not significant, this pattern is consistent with full mediation, suggesting that the work environment influences patient safety primarily through its impact on bedside handover practices. Overall, these mediation results highlight the pivotal role of effective bedside handover as a communication mechanism that translates both nurse competence and work environment conditions into improved patient safety outcomes.

Discussion

Nurse Competence and Bedside Handover

This study indicates that nurses reported generally good levels of competence, particularly in value-based nursing care, suggesting that ethical principles are consistently integrated into daily practice. This aligns with evidence that ethical and clinical competence underpin adherence to safety protocols and support safer decision-making (Zaitoun et al., 2023). However, leadership- and development-related competencies were relatively weaker, reflecting limited opportunities for formal leadership preparation and career progression, a pattern commonly reported in LMIC settings where structured leadership pathways and mentorship systems are still emerging. In contrast, hospitals in many high-income countries (HICs) often embed leadership development within competency-based career ladders and continuing professional development, enabling nurses to coordinate care more assertively and advocate for safety concerns.

From a Socio-Technical Systems perspective, nurse competence represents a key human subsystem that shapes how work processes are carried out. Competent nurses are better able to interpret complex clinical information, prioritize risks, and coordinate team actions. These capabilities are crucial during bedside handover, where they must synthesize patient data, communicate succinctly, and engage patients and families. The significant positive effect of competence on bedside handover in this study suggests that strengthening cognitive, ethical, and communication skills can directly enhance the quality of this critical safety process (Gagnon-Béland et al., 2025; Wieke Noviyanti et al., 2021). Targeted leadership and communication training, particularly in LMIC hospitals where such programs are limited, may therefore yield substantial

gains in handover quality and, ultimately, patient safety.

Work Environment and Bedside Handover

The findings also highlight the role of the work environment as an organizational subsystem that conditions how bedside handover is implemented. High scores on collegial support and sense of community suggest that nurses experience strong teamwork and mutual support. Such relational resources are known to buffer stress, reduce burnout, and foster resilience (Gagnon-Béland et al., 2025; Maghsoud et al., 2022), which in turn facilitates collaborative handover routines. When nurses feel supported and psychologically safe, they are more likely to speak up about concerns, clarify ambiguous information, and share responsibility for maintaining safety standards at the bedside.

At the same time, concerns about fairness in organizational policies point to LMIC-specific structural barriers. Perceived inequities in workload allocation, promotion opportunities, or managerial decision-making can erode trust and engagement, reducing motivation to participate in labor-intensive practices like structured bedside handover fully (Vaamonde et al., 2018). In many LMIC hospitals, chronic understaffing, high patient-to-nurse ratios, and limited managerial transparency make it difficult to allocate sufficient time for comprehensive handovers, even when nurses are willing. This contrasts with many HIC settings where stronger governance frameworks, clearer policy enforcement, and better resourcing create more consistent conditions for standardized safety practices. Within the Socio-Technical Systems framework, these environmental constraints reflect misalignments in the organizational subsystem that can either enable or hinder the enactment of safe communication processes.

Relative Contributions of Nurse Competence and Work Environment to Bedside Handover

The results show that while both nurse competence and the work environment significantly predict bedside handover, the effect of competence is stronger. This suggests that even in supportive environments, bedside handover quality ultimately depends on the individual's ability to integrate clinical reasoning, ethical judgment, and communication skills. Prior research similarly indicates that favorable environments improve teamwork and engagement, but competence remains the decisive factor for ensuring that the content and structure of bedside handover are clinically sound and complete (Cruchinho et al., 2023; Yusrawati et al., 2022).

In Socio-Technical terms, this pattern reflects the idea that organizational supports are necessary but not sufficient: they create conditions under which human capabilities can be fully expressed, but do not replace those capabilities. Optimizing bedside handover in LMIC contexts therefore requires a dual strategy: enhancing individual competencies through education and training, while progressively improving environmental conditions such as staffing, fairness, and communication norms.

Nurse Competence, Work Environment, and Patient Safety: Direct and Indirect Pathways

A key contribution of this study is the joint examination of direct and indirect pathways from nurse competence and work environment to patient safety. Consistent with prior literature, competence showed a direct positive association with patient safety, supporting the view that vigilant, skilled nurses commit fewer errors, identify risks earlier, and adhere more consistently to safety protocols (Zaitoun et al., 2023). This direct pathway represents a classic

human-factor route within Socio-Technical Systems Theory, where individual capacities exert an immediate influence on safety outcomes.

In contrast, the work environment did not exhibit a significant direct effect on patient safety. This differs from many HIC-based studies in which staffing adequacy, autonomy, and managerial support are often found to predict safety outcomes directly. One possible explanation is that in LMIC systems, organizational conditions primarily influence patient safety through proximal work processes such as communication patterns, supervision, and informal coordination rather than exerting a straightforward direct effect. Environmental improvements may enhance safety only when they are translated into concrete practices, such as better-structured bedside handover, rather than automatically improving outcomes.

Theoretical Justification and Interpretation of Mediation

The mediation analysis showed that bedside handover partially mediated the relationship between nurse competence and patient safety and fully mediated the relationship between work environment and patient safety. This pattern is conceptually consistent with Socio-Technical Systems Theory, which posits that safety emerges from the dynamic interaction of human, organizational, and process-level factors rather than from any single component (Daicampi et al., 2025; Saragih et al., 2022). In this model, bedside handover acts as a critical process subsystem that converts human and organizational inputs into safe or unsafe outcomes.

Theoretically, competent nurses bring the knowledge and skills needed to conduct accurate and comprehensive handovers, while a supportive work environment provides time, teamwork, and psychological safety for the process to occur. Bedside handover then becomes the mechanism through which risks are identified, discrepancies are resolved, and patients and families are engaged in safety-related dialogue. The finding of partial mediation for competence suggests that some aspects of competence (e.g., situational awareness, rapid clinical judgment) may influence safety through additional pathways beyond handover, such as real-time decision-making during emergencies. In contrast, the full mediation observed for work environment implies that its influence on safety operates primarily through improving communication and coordination processes. Without effective bedside handover, improvements in the environment may not be sufficient to translate into measurable safety gains.

LMIC–HIC Comparisons and Context-Specific Barriers

Comparing these findings with evidence from HIC settings highlights how context shapes the functioning of Socio-Technical Systems. In HIC hospitals, relatively stable staffing levels, robust information systems, and institutionalized quality-improvement cultures mean that changes in the work environment can have a more direct and immediate impact on safety indicators. In LMIC contexts, however, persistent structural challenges such as high workload, limited access to technology, fragmented documentation systems, and hierarchical communication cultures can dampen or delay the impact of environmental reforms.

Under such conditions, process-level interventions like structured bedside handover may represent a particularly pragmatic strategy. They require relatively modest financial resources but can substantially improve the reliability of information transfer, increase patient involvement, and strengthen accountability.

By embedding safety behaviors into everyday routines, bedside handover can partially offset systemic constraints, making it an especially valuable leverage point in LMIC hospitals.

Unexpected Findings and Possible Explanations

The non-significant direct effect of work environment on patient safety was an unexpected finding, given that prior studies, especially those from HICs, often report a direct association between environmental factors and safety outcomes. Several explanations are plausible. First, there may be a threshold effect. Once a minimally acceptable work environment is achieved, further improvements primarily enhance proximal processes (such as communication) rather than producing additional direct gains in safety. Second, the generally positive mean scores for work environment dimensions may indicate restricted variability, reducing statistical power to detect direct effects. Third, some critical aspects of the environment in LMIC hospitals, such as staffing ratios, availability of equipment, or leadership style, were not included in the measurement model and may have attenuated the observable direct association.

Another unexpected nuance is the relatively strong indirect effect of work environment through bedside handover. This suggests that in the participating hospitals, environmental conditions may be particularly important for enabling or constraining communication behaviors, rather than directly shaping clinical outcomes. For example, where team relationships are strong and fairness is perceived as higher, nurses may feel more comfortable engaging in detailed, patient-centered handovers, thereby indirectly improving safety.

Implications and Limitations

Theoretically, this study reinforces Socio-Technical Systems Theory by empirically demonstrating that patient safety in LMIC hospitals is best understood as the outcome of interacting human, organizational, and communication subsystems. Practically, the findings suggest that investment in nurse competence especially leadership and communication and the institutionalization of structured bedside handover should be prioritized alongside progressive improvements in the work environment. For LMIC policymakers and hospital managers, bedside handover offers a cost-effective, communication-based intervention that can help bridge the gap between policy-level safety aspirations and everyday clinical realities.

Several limitations must be acknowledged. The cross-sectional design prohibits causal inference, and the use of self-report instruments introduces potential social-desirability and common-method biases. The sample was drawn from four hospitals within a single Indonesian province, which may limit generalizability to other regions or health systems. Additionally, important contextual variables such as staffing ratios, objective workload measures, or specific leadership styles were not included and may further clarify the pathways linking competence, environment, bedside handover, and safety. Future longitudinal and multi-site studies, incorporating both subjective and objective indicators, are needed to test the robustness of the proposed model across diverse LMIC and HIC settings.

Relevance to Practice

The findings of this study highlight that improving patient safety in LMIC hospital settings requires strengthening both individual nursing competence and

organizational systems that support effective bedside handover. For nursing educators, this means integrating structured training in leadership, communication, and clinical judgment into continuing education programs to ensure nurses can confidently deliver clear, patient-centered handovers. For nurse managers, implementing standardized bedside handover tools such as checklists, scripts, or ISBAR formats can reduce variability and communication gaps while promoting consistent team engagement. Hospital administrators and policymakers can enhance fairness, transparency, and team climate by improving workload distribution, clarifying promotion pathways, and embedding bedside handover quality into unit-level safety governance and performance evaluations. These interventions are feasible in LMIC contexts because they rely more on capacity-building and workflow redesign than on high-cost technologies, making bedside handover a practical, scalable strategy to strengthen patient safety across diverse hospital environments.

Conclusion

This study demonstrates that nurse competence and the work environment both contribute to patient safety, with bedside handover serving as the key process that links these factors to safer clinical outcomes. Strengthening competence alone is not sufficient; hospitals must also ensure supportive, fair, and collaborative environments that enable nurses to perform high-quality bedside handovers. The findings highlight bedside handover as a practical, low-cost strategy for improving communication and reducing preventable errors in resource-constrained LMIC settings. Future research should explore longitudinal effects of bedside handover interventions, examine additional organizational factors such as staffing and leadership style, and evaluate implementation strategies across diverse hospital contexts.

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CrediT Authorship Contributions Statement

Sova Nova Kaparang : Conceptualization, Methodology, Data Collection, Writing – Original Draft.

Kuswantoro Rusca Putrai: Supervision, Data Analysis, Writing – Review & Editing.

Rinik Eko Kapti: Data Collection, Formal Analysis, Writing – Review & Editing.

Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this article.

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Supplementary Materials

Supplementary File S1: Research Instrument contains the full questionnaire used for data collection.

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