

Length of Stay, Nursing Staffing Intensity, and Discharge Against Medical Advice as Determinants of Bed Occupancy Rate: Panel Evidence from Landak Regional Hospital, Indonesia

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ABSTRACT: This study examines unit-level determinants of Bed Occupancy Rate (BOR) at Landak Regional Hospital, West Kalimantan, Indonesia, by focusing on average Length of Stay (LOS), Nursing Staffing Intensity (ITK), and Discharge Against Medical Advice (DAMA). A retrospective quantitative panel design was applied to a balanced dataset of 168 unit-month observations covering seven inpatient units over 24 months (January 2024-December 2025). Model selection used Chow, Breusch-Pagan Lagrange Multiplier, and Hausman tests. Because heteroskedasticity and cross-sectional dependence were detected, primary inference used a Fixed Effect Model with Panel-Corrected Standard Errors (PCSE). Mean BOR was 49.39%, below the 60-85% efficiency range set by the Indonesian Ministry of Health [11]. LOS was not significantly associated with BOR ($B=0.6615$, $p=0.5800$). Nursing staffing intensity showed a significant negative association under PCSE ($B=-0.1806$, $p=0.0292$), while DAMA was negative but did not reach the 5% significance level ($B=-0.4488$, $p=0.0735$). Sensitivity checks using unit-clustered and Driscoll-Kraay standard errors weakened the 5% significance of the ITK coefficient, indicating estimator-sensitive inference. The three predictors were jointly significant under the primary PCSE specification (Wald $F=2.9717$, $p=0.0336$); the fixed-effect model had an adjusted R-squared of 0.5614 but a within-unit R-squared of only 0.0643. Because BOR rose by a common 0.86 percentage points per month, time-adjusted specifications were also estimated: with a linear trend or month fixed effects, the ITK coefficient attenuated to approximately -0.10 and was not significant under any covariance estimator ($p \geq 0.16$), whereas the LOS coefficient became positive ($B=2.11-2.72$) and was significant under all estimators in the two-way fixed-effects model ($p \leq 0.026$). The findings emphasize persistent differences among inpatient units; the staffing association is not robust to time adjustment and should not be read as a causal effect of nurse numbers on occupancy. Unit-specific capacity planning, responsive staff redistribution, and targeted DAMA reduction are therefore more appropriate than uniform hospital-wide interventions.

KEYWORDS - bed occupancy rate, length of stay, nursing staffing intensity, discharge against medical advice, panel data, hospital capacity management

I. Introduction

Hospital bed occupancy is a central operational indicator because beds are a finite and perishable resource: unused capacity cannot be stored, while sustained pressure can create bottlenecks and reduce resilience. BOR therefore reflects the interaction between demand for inpatient care, available capacity, and the speed with which patients move through admission, treatment, and discharge. Evidence from the English National Health Service shows that occupancy is shaped by demand-supply conditions and is associated with selected quality outcomes, highlighting the need to interpret occupancy within the wider patient-flow system rather than as a stand-alone percentage [1]. A 25-hospital cohort study likewise found that rising occupancy was associated with slower patient flow and longer emergency-department stays, while critical congestion points varied across hospitals [17]. Comparative

work on ordinary hospital-bed management similarly emphasizes that occupancy should be examined together with length of stay and other resource-use indicators [2].

The operational challenge at Landak Regional Hospital is not simply low occupancy. Across seven inpatient units and 24 months, the mean BOR was 49.39%. Of 168 unit-month observations, 114 (67.9%) were below 60%, 46 (27.4%) were within the 60-85% efficiency range set by the Indonesian Ministry of Health [11], and eight (4.8%) exceeded 85%. Thus, under-utilization and episodes of capacity pressure coexisted within the same institution. The annual average improved from 44.06% in 2024 to 54.72% in 2025, but persistent differences among units remained. These patterns are consistent with the broader capacity-management argument that bed use must be monitored according to local inflow, outflow, and resource-allocation conditions [3].

Three operational mechanisms are particularly relevant. First, LOS influences how long a bed remains occupied before it can be made available to another patient. Longer stays may increase occupied bed-days, but may also restrict new admissions when capacity is constrained. Studies of patient flow identify timely discharge, coordination, and resource-capacity matching as recurrent determinants of hospital throughput [4]. Research on hospital LOS further shows that prolonged stays are associated with important patient outcomes and reflect the combined effect of clinical complexity and care processes [5].

Second, nursing resources are integral to patient flow because assessment, coordination, education, clinical monitoring, and discharge preparation depend on sufficient staffing. A prospective panel study in Queensland found that improved nurse staffing after implementation of nurse-to-patient ratio legislation was associated with lower mortality, readmissions, and length of stay [6]. A systematic review of longitudinal studies similarly supports beneficial associations between higher registered-nurse staffing and patient outcomes, while emphasizing substantial heterogeneity in how staffing exposure is measured across studies [18]. At Landak Regional Hospital, however, the staffing measure is operationalized as the ratio of active nurses to the number of inpatients recorded in the unit's monthly census. Consequently, a high nursing-intensity ratio may represent relatively high staffing capacity when census is low, while a low ratio may represent heavier demand relative to staffing. This denominator structure requires careful interpretation of the coefficient in the occupancy model.

Third, DAMA represents an unplanned termination of inpatient care before the treating team recommends discharge. DAMA is not an efficiency mechanism even though it can release beds earlier. It is associated with increased risk of unplanned readmission and mortality and is therefore better understood as a patient-retention and quality concern [7]-[9]. A narrative review further characterizes DAMA as a heterogeneous event with important patient-safety and communication implications and recommends a systematic, patient-centered approach to prevention and management [19]. At Landak Regional Hospital, DAMA cases increased from 158 in 2024 to 179 in 2025, despite improvement in average occupancy, suggesting that occupancy gains did not automatically resolve problems in continuity of care.

Most local occupancy evaluations are conducted as descriptive or cross-sectional analyses. Such approaches can identify differences among wards but cannot distinguish persistent unit characteristics from month-to-month changes within the same unit. This distinction is important because inpatient units differ structurally in case mix, service function, staffing requirements, bed capacity, and admission patterns. A panel-data specification can explicitly control these time-invariant unit characteristics and thereby clarify whether an observed relationship is driven by structural differences between units or by temporal changes within units [1].

Accordingly, this study examines the partial and joint associations of LOS, nursing staffing intensity, and DAMA with BOR across seven inpatient units of Landak Regional Hospital during 2024-2025. Its contribution is twofold. Empirically, it provides a unit-month panel assessment of occupancy determinants in a regional Indonesian public hospital. Methodologically, it demonstrates how fixed effects and robust standard errors can change the interpretation of apparently strong bivariate relationships, particularly for LOS and nursing staffing intensity. The resulting evidence is intended to support unit-specific capacity planning rather than a uniform hospital-wide response.

II. Literature Review and Hypothesis Development

2.1 Length of Stay and Bed Occupancy Rate

LOS is the average duration of inpatient care before discharge and is directly linked to the number of occupied bed-days generated by a given patient volume. From a capacity-management perspective, a longer LOS can increase occupancy because each episode consumes bed capacity for more days. At the same time, excessive LOS may create stagnation, reduce bed turnover, and limit new admissions. Research on hospital outcomes confirms that LOS is not merely a utilization statistic; it also reflects clinical complexity, care coordination, and discharge

processes [5]. Recent literature on LOS prediction likewise treats LOS as a critical variable for resource allocation and bed availability [10].

Because the present study models monthly unit-level occupancy, the theoretical expectation is that longer average stays are associated with higher BOR, after accounting for nursing intensity, DAMA, and unit-specific fixed characteristics. H1 is therefore stated as follows: H1. Average length of stay has a positive and significant association with BOR.

2.2 Nursing Staffing Intensity and Bed Occupancy Rate

Nursing capacity influences the speed and reliability of inpatient processes from admission through active care to discharge. Adequate staffing supports care coordination, patient education, and discharge preparation; better staffing has been associated with improved patient outcomes [18] and shorter LOS [6]. In this study, nursing staffing intensity (ITK) is defined as the number of active nurses assigned to a unit relative to the number of inpatients recorded in that unit's monthly census, so a higher ratio indicates more nursing capacity per patient treated.

Where nursing capacity per patient is higher, discharge-related processes can be completed more promptly, shortening occupied bed-days per episode; a negative association between ITK and BOR is therefore expected. Because ITK and BOR both depend on monthly patient volume, however, the coefficient cannot be interpreted as a causal effect of nurse numbers; this measurement issue is examined in the Discussion. H2 is stated as follows: H2. Nursing staffing intensity has a negative and significant association with BOR.

2.3 Discharge Against Medical Advice and Bed Occupancy Rate

DAMA occurs when a patient leaves hospital before the medical team recommends discharge. Reviews identify DAMA as a complex event related to patient, communication, social, and service factors [8]. Large observational studies also show substantially higher subsequent readmission and mortality among patients leaving against medical advice [7], [9]. Operationally, an early unplanned departure shortens the current bed episode and can temporarily reduce occupied bed-days, even though the process represents incomplete care rather than productive turnover.

Accordingly, higher DAMA rates are expected to be associated with lower BOR at the unit-month level, while the managerial interpretation remains negative because the mechanism reflects premature termination of care. H3 is stated as follows: H3. DAMA has a negative and significant association with BOR.

2.4 Joint Determinants of Bed Occupancy Rate

Hospital occupancy emerges from interacting demand, capacity, staffing, and discharge processes rather than a single determinant. Patient-flow research emphasizes a whole-system perspective that aligns resources, timely discharge, and service coordination [4]. Capacity studies also show that local inflow and outflow patterns can produce substantial differences in bed use across service settings [3]. Therefore, the three operational variables are evaluated jointly within a fixed-effects panel framework. H4 is stated as follows: H4. LOS, nursing staffing intensity, and DAMA jointly have a significant association with BOR.

III. Methods

3.1 Study Design and Setting

This study used a quantitative retrospective panel-data design. The unit of analysis was an inpatient unit-month rather than an individual patient. Seven active inpatient units at Landak Regional Hospital, West Kalimantan, Indonesia, were observed for 24 consecutive months from January 2024 through December 2025, yielding a balanced panel of 168 observations. The units were Mentawa (internal medicine), Tabodol (surgery), Kalawit (obstetrics), Paluntan (pediatrics), the intensive care unit, Pehengan, and Sarikan.

The design was selected to separate two sources of variation: differences between inpatient units and changes within the same unit over time. This distinction is important because units differ in service function, patient characteristics, staffing requirements, and baseline utilization.

3.2 Data Sources and Variables

Data were obtained retrospectively from institutional operational records. Daily inpatient census and patient-mobility reports from the Hospital Management Information System (SIMRS) were used for BOR and discharge status; electronic medical-record reports were used to calculate LOS; and monthly nursing reports were used to obtain the number of active nurses in each inpatient unit. Access to these records was granted through formal institutional permission from the hospital director. The analysis used only aggregated unit-month operational indicators, with no patient-level or identifiable data; accordingly, formal research ethics committee review was

not sought. The final analytical dataset contained aggregated unit-month indicators, and no individual patient identifier is reported in this article.

BOR was calculated as patient-days divided by the product of available beds and calendar days in the month, multiplied by 100. LOS was calculated as total days of care divided by the number of discharged patients in each unit-month, including all discharge types (recovered, died, referred, and DAMA). Nursing staffing intensity (ITK) was calculated as the number of active nurses assigned to a unit divided by the number of inpatients recorded in the unit's monthly census (patients treated during the month), expressed as a percentage. DAMA was calculated as the number of patients leaving against medical advice divided by the same monthly patient census, multiplied by 100. This staffing-to-patient formulation, adapted from the nurse-to-patient ratio concept [6], determines how the ITK coefficient should be interpreted.

3.3 Statistical Analysis

Descriptive statistics summarized mean, standard deviation, minimum, and maximum values. Panel-model selection proceeded through the Chow test for pooled versus fixed effects, the Breusch-Pagan Lagrange Multiplier test for pooled versus random effects, and the Hausman test for fixed versus random effects. Pooled ordinary least squares and random-effects (Swamy-Arora) estimates are reported for comparison. Model selection, diagnostics, and the primary estimates were obtained in EViews 12; the covariance sensitivity analyses and time-adjusted models were computed from the same unit-month dataset using Python (NumPy/SciPy) scripts, which reproduced the EViews coefficients exactly.

Diagnostic testing identified groupwise heteroskedasticity and contemporaneous cross-sectional dependence, while first-order serial correlation was not detected. The primary model therefore used Fixed Effects with Panel-Corrected Standard Errors (PCSE), calculated without degrees-of-freedom correction, because PCSE is designed to accommodate heteroskedasticity and contemporaneous correlation in time-series cross-sectional data [12]. However, PCSE estimates the contemporaneous cross-sectional covariance structure from a finite number of time observations, so finite-sample precision depends on the panel dimensions [13]. In this study $N=7$ and $T=24$ ($T/N=3.43$); PCSE is computationally feasible, but the limited number of units and only 24 observations per unit warrant cautious inference. Driscoll-Kraay covariance estimation provides an alternative that is robust to general forms of cross-sectional and temporal dependence as the time dimension increases [14]. At the same time, modern guidance on clustered inference emphasizes that conventional cluster-robust procedures can be unreliable when the number of clusters is small [15], [16]. Accordingly, PCSE is retained as the primary estimator while alternative covariance estimators are used as sensitivity checks rather than treating a single p-value as definitive. All primary hypothesis decisions used a 5% significance level; p-values between 0.05 and 0.10 are described as borderline evidence rather than statistically significant.

The final specification was: $BOR_{it} = \alpha_i + \beta_1 LOS_{it} + \beta_2 ITK_{it} + \beta_3 DAMA_{it} + e_{it}$, where α_i is the unit-specific fixed intercept. Standardized coefficients were computed post hoc as $b(SD_X/SD_{BOR})$ using the overall standard deviations of the 168 observations reported in the descriptive statistics, not standard deviations from within-transformed variables. Because fixed-effects coefficients are identified from within-unit variation, these standardized values are reported only as descriptive scale-adjusted summaries and are not used to rank predictor importance. As an inferential sensitivity check, the same fixed-effects specification was re-evaluated using (1) standard errors clustered by inpatient unit with finite-cluster correction and (2) Driscoll-Kraay standard errors with a Bartlett kernel and two monthly lags [14]-[16]. These procedures change the estimated covariance matrix, not the fixed-effects coefficients. The cluster-based results are themselves interpreted cautiously because only seven clusters are available [15], [16].

Because mean BOR increased markedly during the observation period and residual cross-sectional dependence can reflect common hospital-wide shocks, two time-adjusted specifications were estimated as robustness analyses: (1) unit fixed effects plus a linear monthly trend and (2) two-way fixed effects with unit and month effects (23 month indicators). Each was evaluated with PCSE, unit-clustered, and Driscoll-Kraay standard errors using the same settings as the primary model. The one-way specification was retained for hypothesis decisions because it was specified in the original analysis plan; the time-adjusted estimates are used to assess the robustness of those decisions.

IV. Results

4.1 Descriptive Characteristics

The balanced panel contained 168 observations with no missing unit-month records. Mean BOR was 49.39% ($SD=20.69$), with values ranging from 6.67% to 99.03%. Occupancy improved from an annual average of 44.06%

in 2024 to 54.72% in 2025. Nevertheless, 67.9% of all observations remained below 60%, while 4.8% were above 85%, confirming simultaneous under-utilization and episodic capacity pressure across different units.

Table 1. Descriptive statistics of study variables

Variable	Mean	SD	Minimum	Maximum
BOR (%)	49.39	20.69	6.67	99.03
LOS (days)	3.67	1.67	0.86	9.62
Nursing staffing intensity / ITK (%)	39.71	34.67	11.02	183.33
DAMA (%)	5.05	6.21	0.00	35.71

LOS averaged 3.67 days and declined from 3.85 days in 2024 to 3.48 days in 2025 despite the increase in BOR. Nursing staffing intensity was highly dispersed; the unit-level mean ranged from 16.82% in Kalawit to 107.16% in Pehengan, indicating substantial mismatch between staffing capacity and patient census. DAMA averaged 5.05%. The absolute number of DAMA cases increased from 158 in 2024 to 179 in 2025, and the highest unit-level average was observed in Pehengan.

Table 2 summarizes unit-level characteristics. Mean monthly patient volume ranged from 12.4 in Pehengan to 99.3 in Kalawit, whereas the mean number of active nurses varied less (11.5-18.5 per unit), so that ITK largely mirrored differences in patient volume. Across all units, total monthly patient volume increased by 14.6% from 2024 to 2025 (4,576 to 5,245 patients), while the mean number of active nurses per unit increased by 4.9% (13.75 to 14.43).

Table 2. Characteristics of inpatient units (means over 24 months)

Unit	Service	Patients per month	Active nurses	BOR (%)	LOS (days)	ITK (%)	DAMA (%)	DAMA cases 2024 / 2025
Mentawa	Internal medicine	87.2	18.5	61.20	4.85	22.67	5.32	50 / 58
Tabodol	Surgery	83.6	16.4	64.02	3.28	20.05	2.41	21 / 28
Kalawit	Obstetrics	99.3	16.1	32.11	1.51	16.82	0.00	0 / 0
Paluntan	Pediatrics	62.0	11.6	33.31	2.51	20.37	2.55	18 / 18
ICU	Intensive care	19.7	12.0	29.64	3.38	64.36	3.86	8 / 10
Pehengan	General ward	12.4	12.5	61.94	5.75	107.16	13.09	20 / 19
Sarikan	General ward	45.0	11.5	63.52	4.40	26.57	8.12	41 / 46

Patients per month = monthly patient census used as the denominator of ITK and DAMA.

4.2 Model Selection and Diagnostic Tests

Table 3. Panel-model selection and diagnostic tests

Test	Statistic	p-value	Interpretation
Chow test	F=20.1135	<0.001	Fixed effects preferred to pooled model
Breusch-Pagan LM	chi-square=123.6286	<0.001	Significant individual effects
Hausman test	chi-square=10.9271, df=3	0.0121	Fixed effects preferred to random effects
Modified Wald	chi-square=119.1840	<0.001	Groupwise heteroskedasticity
Wooldridge	F=1.8095	0.1806	No first-order autocorrelation detected

Test	Statistic	p-value	Interpretation
Cross-sectional dependence (BP-LM)	chi-square=46.4524	0.0011	Cross-sectional dependence detected
Jarque-Bera (residuals)	JB=7.0153	0.0299	Mild non-normality (skewness 0.48)

The three model-selection procedures converged on the Fixed Effect Model. Variance Inflation Factor values ranged from 1.3852 to 1.4260, indicating no problematic multicollinearity. Residuals showed a mild departure from normality (Jarque-Bera=7.0153, $p=0.0299$; skewness=0.48, kurtosis=3.26); with $n=168$, inference relies on the large-sample approximation for the coefficient estimators. Because heteroskedasticity and cross-sectional dependence were present, PCSE was used for the final inferential statistics.

Table 4 compares the pooled, random-effects, and fixed-effects estimates. The LOS coefficient declined from 6.8227 in the pooled model to 1.7068 in the random-effects model and 0.6615 in the fixed-effects model, and the DAMA coefficient changed from positive (0.3113) in the pooled model to negative in the random- and fixed-effects models, indicating that between-unit heterogeneity substantially confounded the pooled associations.

Table 4. Coefficient estimates across panel specifications

Predictor	Pooled OLS	Random effects	Fixed effects (conventional SE)	Fixed effects (PCSE, primary)
LOS	6.8227 (0.9764); $p<0.001$	1.7068 (1.0489); $p=0.1056$	0.6615 (1.0735); $p=0.5386$	0.6615 (1.1930); $p=0.5800$; 95% CI -1.695 to 3.018
ITK	-0.1626 (0.0476); $p=0.0008$	-0.1357 (0.0672); $p=0.0451$	-0.1806 (0.0732); $p=0.0147$	-0.1806 (0.0821); $p=0.0292$; 95% CI -0.343 to -0.019
DAMA	0.3113 (0.2626); $p=0.2376$	-0.3119 (0.2272); $p=0.1717$	-0.4488 (0.2263); $p=0.0490$	-0.4488 (0.2491); $p=0.0735$; 95% CI -0.941 to 0.043
R-squared	0.2681	-	0.5850 (within 0.0643)	0.5850 (within 0.0643)

Values are B (SE); p . Random effects were estimated with the Swamy-Arora method. PCSE were computed without degrees-of-freedom correction.

4.3 Final Fixed-Effects Estimates and Hypothesis Tests

Table 5. Final Fixed Effect Model with Panel-Corrected Standard Errors

Path	B	PCSE SE	t	p	Std. beta*	Decision (5%)
H1: LOS → BOR	0.6615	1.1930	0.5545	0.5800	0.0533	Not supported
H2: ITK → BOR	-0.1806	0.0821	-2.2006	0.0292	-0.3026	Supported
H3: DAMA → BOR	-0.4488	0.2491	-1.8019	0.0735	-0.1347	Not supported

* Standardized beta was calculated from overall sample SDs (not within-transformed SDs) and is reported descriptively only; it is not used to rank predictor importance.

LOS had a positive but non-significant coefficient ($B=0.6615$, 95% CI -1.695 to 3.018, $p=0.5800$), so H1 was not supported. Under the primary PCSE specification, nursing staffing intensity had a significant negative coefficient ($B=-0.1806$, 95% CI -0.343 to -0.019, $p=0.0292$), supporting H2 at the 5% level. DAMA was negatively associated with BOR ($B=-0.4488$, 95% CI -0.941 to 0.043) but did not meet the 5% significance criterion after PCSE correction ($p=0.0735$); H3 was therefore not supported at the primary significance level, although the direction was consistent with the hypothesis. Table 5 reports overall-SD standardized betas for scale adjustment only. Because these values are based on overall rather than within-transformed standard deviations, no claim of predictor dominance is made from their magnitude.

The joint Wald test was significant ($F=2.9717$, $df=3,158$, $p=0.0336$), supporting H4. The fixed-effects model had $R\text{-squared}=0.5850$ and adjusted $R\text{-squared}=0.5614$. The within-unit $R\text{-squared}$ was 0.0643. This difference is substantively important: much of the overall explanatory power came from persistent differences among inpatient units captured by their fixed effects rather than from month-to-month changes in the three observed predictors alone.

4.4 Sensitivity Analysis

Because the panel contains only seven cross-sectional units, the primary PCSE inference was compared with unit-clustered and Driscoll-Kraay covariance estimators [14]-[16]. The coefficient signs and magnitudes are unchanged across these checks, but individual p -values are sensitive to the covariance estimator, as shown in Table 6.

Table 6. Sensitivity of fixed-effects inference to covariance estimator

Predictor	B	PCSE p	Clustered p	Driscoll-Kraay p
LOS	0.6615	0.5800	0.6222	0.5016
ITK	-0.1806	0.0292	0.2654	0.0620
DAMA	-0.4488	0.0735	0.0358	0.0702

The ITK coefficient remains negative in all specifications, but its 5% significance is not robust: $p=0.2654$ with unit-clustered standard errors and $p=0.0620$ with Driscoll-Kraay standard errors. DAMA is similarly estimator-sensitive, reaching 5% significance only under the unit-clustered covariance. The joint slope restrictions remain significant under both alternative checks (cluster-robust $F=5.3853$, $p=0.0388$; Driscoll-Kraay Wald chi-square=28.9594, $p<0.001$), but the individual predictor evidence should be interpreted cautiously. With only seven clusters, the cluster-robust p -values are also subject to finite-cluster uncertainty [15], [16].

4.5 Time-Adjusted Specifications

Mean BOR increased by 0.86 percentage points per month (linear trend in the unit fixed-effects model; PCSE $p<0.001$, unit-clustered $p=0.032$), and the month indicators were jointly significant in the two-way model ($F=2.66$, $df=23,135$, $p<0.001$). Adding a linear trend removed the residual cross-sectional dependence detected in the primary model (Pesaran $CD=0.24$, $p=0.808$), suggesting that this dependence largely reflected a hospital-wide trend. Adjusting for common time variation changed the individual coefficients materially (Table 7).

Table 7. Fixed-effects estimates after adjustment for common time effects

Predictor	B (trend)	PCSE p	Clustered p	D-K p	B (two-way)	PCSE p	Clustered p	D-K p
LOS	2.1147	0.0640	0.1441	0.0259	2.7183	0.0190	0.0255	0.0008
ITK	-0.0961	0.2211	0.4011	0.3009	-0.1000	0.2342	0.3522	0.2879
DAMA	-0.4181	0.0794	0.0622	0.0569	-0.4244	0.0860	0.1253	0.0897

Trend model: unit fixed effects plus a linear monthly trend ($B=0.8573$ per month; within $R\text{-squared}$ including trend=0.2315). Two-way model: unit and month fixed effects (within $R\text{-squared}=0.0912$). Joint test of the three predictors under PCSE: $F=2.8743$, $p=0.0381$ (trend) and $F=3.6142$, $p=0.0150$ (two-way). Clustered: by inpatient unit with finite-cluster correction ($df=6$). D-K: Driscoll-Kraay (Bartlett kernel, two lags).

In both time-adjusted models, the ITK coefficient attenuated by 45-47% (from -0.1806 to -0.0961 and -0.1000) and was not significant under any covariance estimator ($p=0.160$ -0.401, including conventional standard errors). The LOS coefficient increased to 2.1147 with a linear trend and 2.7183 with month fixed effects; in the two-way model it was significant under all covariance estimators ($p=0.0008$ -0.0255), whereas in the trend model it was significant with Driscoll-Kraay standard errors ($p=0.0259$), borderline under PCSE ($p=0.0640$), and non-significant with unit clustering ($p=0.1441$). The DAMA coefficient was stable in magnitude (-0.4181 and -0.4244) and remained borderline ($p=0.0439$ -0.1253). Hypothesis decisions based on the primary model should therefore be read together with these time-adjusted results.

V. Discussion

5.1 Occupancy Pattern and Unit Heterogeneity

The descriptive results show that the central capacity problem at Landak Regional Hospital is heterogeneous utilization. Average BOR remained below the national efficiency range set by the Indonesian Ministry of Health [11], yet several unit-months exceeded 85%. The same hospital therefore experienced idle capacity in some units

and pressure episodes in others. This pattern is compatible with capacity-management literature showing that occupancy is shaped by local demand, patient flow, and resource allocation rather than by bed numbers alone [1], [3]. Recent multi-hospital evidence also indicates that increasing occupancy can impair patient flow and that the occupancy level at which congestion emerges is context-specific rather than universal [17].

The improvement from 44.06% to 54.72% between 2024 and 2025 indicates meaningful progress, but it does not eliminate the structural gap among units. The fixed-effects results reinforce this point because unit-specific intercepts accounted for a substantial portion of the model's explanatory power. A single hospital-wide occupancy policy would therefore risk overlooking the distinct functions of an ICU, an obstetric ward, a surgical ward, and general inpatient units.

5.2 LOS: Between-Unit Confounding and Common Time Trends

The LOS result is methodologically informative. In the pooled model (Table 4), LOS appeared strongly and positively related to BOR ($B=6.8227$). After unit fixed effects were introduced, however, the coefficient fell to 0.6615 and became non-significant. This indicates that the apparent LOS-BOR relationship was primarily a between-unit phenomenon: units with chronically longer stays also tended to have higher baseline occupancy, but month-to-month changes in LOS within the same unit did not independently explain occupancy once persistent unit characteristics were controlled.

The time-adjusted models qualify this interpretation. During the study period, LOS declined (3.85 to 3.48 days) while occupancy rose across the hospital. In the one-way model, this opposite hospital-wide movement is absorbed into the within-unit LOS coefficient and can mask a positive month-to-month relationship. Once common time variation was removed, LOS showed a positive within-unit association with BOR ($B=2.11-2.72$), which was statistically significant in the two-way model under all covariance estimators. The non-significant LOS coefficient in the primary model should therefore not be interpreted as evidence that within-unit changes in LOS are unrelated to occupancy; it reflects the combined influence of between-unit heterogeneity and a common time trend.

This finding does not imply that LOS is unimportant for bed management. LOS remains a core measure of patient flow and is related to resource use and outcomes [5], [10]. Rather, it shows that a managerial response based only on shortening LOS would not necessarily raise or stabilize BOR in every unit. The relevant question is why specific units have persistently different LOS profiles and how those profiles interact with admissions, case mix, discharge readiness, and bed availability.

5.3 Nursing Staffing Intensity: Estimator and Specification Sensitivity

Under the primary PCSE specification, nursing staffing intensity was the only individual predictor that reached the 5% significance level. However, the sensitivity analysis shows that this inferential conclusion is estimator-dependent: the coefficient remains negative but becomes non-significant with unit-clustered standard errors ($p=0.2654$) and borderline with Driscoll-Kraay standard errors ($p=0.0620$). The finding should therefore be interpreted as a stable negative coefficient direction with uncertain 5% significance, not as a definitively dominant predictor. The negative sign itself still requires careful substantive interpretation. ITK has monthly patient volume in its denominator, whereas BOR also increases with patient volume. When patient volume rises without a proportional staffing increase, BOR tends to rise while ITK falls. Part of the negative association is therefore structural and definitional rather than evidence of a harmful effect of nursing resources.

The time-adjusted models sharpen this interpretation. Between 2024 and 2025, total monthly patient volume increased by 14.6%, whereas the mean number of active nurses per unit increased by 4.9%, so ITK declined while BOR rose across the hospital. After a linear trend or month fixed effects were included, the ITK coefficient attenuated by 45-47% and was not significant under any covariance estimator. Much of the negative ITK-BOR association in the primary model therefore appears to reflect a common hospital-wide pattern in which patient volume grew faster than nurse staffing, rather than unit-specific month-to-month variation. H2 was supported only under the primary specification and should be regarded as not robust.

The managerial interpretation is a problem of allocation. Very high ITK values occurred in low-census units, while several higher-volume units operated with much lower staffing-to-census ratios. Evidence from other settings shows that adequate nurse staffing supports care quality and can reduce length of stay and adverse outcomes [6]. Longitudinal evidence further indicates that higher registered-nurse staffing is generally beneficial, while the wide variation in staffing metrics across studies cautions against interpreting any single ratio as a universal measure of adequacy [18]. The Landak result is consistent with that broader evidence when it is read as a signal that nurse distribution should follow actual patient load more responsively. The appropriate intervention

is not to reduce nurses where ITK is high simply to increase occupancy, but to evaluate floating, redistribution, rostering, and skill mix so that staffing capacity better matches unit demand.

5.4 DAMA and the Quality-Utilization Trade-off

DAMA showed the hypothesized negative direction, but its inferential status also varies with the covariance estimator. Under the primary PCSE specification, $p=0.0735$, indicating borderline rather than 5% significance. The unit-clustered estimate yields $p=0.0358$, whereas Driscoll-Kraay yields $p=0.0702$. This pattern reinforces the need to treat the DAMA coefficient as suggestive rather than conclusive. The direction is stable, but the evidence does not support a definitive claim of a statistically robust individual effect across reasonable covariance specifications. After adjustment for common time effects, the DAMA coefficient remained stable in magnitude (-0.42) with p -values between 0.044 and 0.125.

Nevertheless, DAMA remains operationally important. Premature departure can release a bed earlier and lower current occupied bed-days, but this is not an efficiency gain. Studies from the United Kingdom and Italy show that DAMA is associated with substantially higher risk of readmission and mortality [7], [9], while reviews emphasize communication, psychosocial, patient-safety, and service factors as potential targets for prevention [8], [19]. The increase in DAMA cases at Landak Regional Hospital therefore warrants quality-improvement action independently of whether its monthly association with BOR crosses the 5% threshold.

5.5 Joint Effects and Capacity-Management Implications

The joint model was significant under PCSE, supporting the view that occupancy is produced by interacting operational processes. The joint restriction also remained significant in the two sensitivity checks and in both time-adjusted specifications under PCSE ($F=2.8743$, $p=0.0381$ with a linear trend; $F=3.6142$, $p=0.0150$ with month fixed effects), although individual coefficients were less stable. At the same time, the low within R-squared of 0.0643 shows that the three monthly indicators explain only a modest portion of changes occurring inside a given unit over time. The common time trend itself was a major source of within-unit variation: the within R-squared increased to 0.2315 when a linear trend was added, underscoring the role of hospital-wide demand growth. Admissions volume, referral patterns, disease seasonality, case mix, bed closures, financing arrangements, and other demand-side factors are plausible additional determinants.

For management, the main implication is differentiation. Low-baseline units require investigation of demand generation and referral pathways; units with recurrent high occupancy require capacity and flow management; units with extreme staffing-to-census ratios require staffing realignment; and units with high DAMA require patient-retention and communication interventions. This unit-specific approach is consistent with the broader literature emphasizing whole-system patient-flow management [4] and the need to monitor local capacity and resource-allocation patterns [3].

VI. Theoretical and Practical Implications

6.1 Theoretical Implications

The study contributes to hospital-operations research by demonstrating that an occupancy determinant can operate differently at the between-unit and within-unit levels. The loss of LOS significance after fixed effects were introduced indicates that a strong pooled relationship may reflect persistent ward characteristics rather than a dynamic monthly mechanism. The time-adjusted results add a second lesson: when a common trend moves occupancy and an operational indicator in opposite directions, one-way fixed effects can mask a genuine within-unit association. Both unit and time heterogeneity should therefore be modelled explicitly. This supports the use of panel methods when operational indicators are repeatedly observed across heterogeneous hospital units.

The study also clarifies the interpretation of staffing ratios in occupancy models. Because staffing intensity and occupancy can share patient census as an underlying component, coefficients may contain structural endogeneity. The result therefore supports a conceptual distinction between staffing sufficiency and staffing-to-demand alignment. Future models should explicitly account for this measurement relationship rather than treating the nursing-intensity coefficient as a simple causal effect.

6.2 Practical Implications

Landak Regional Hospital should institutionalize a unit-level dashboard integrating BOR, LOS, nursing staffing intensity, and DAMA by month. Trend thresholds should trigger targeted review rather than automatic action. For persistent low-occupancy units, management should assess referral networks, admission pathways, service demand, and the appropriateness of bed allocation. For units with recurrent high occupancy, the focus should be on bottleneck removal, discharge coordination, and capacity contingency planning.

Nursing leadership should review staffing distribution against real patient census and service acuity. A responsive floating mechanism and periodic roster rebalancing may improve workload equity without assuming that the total number of nurses is the primary problem. DAMA should be monitored as a quality indicator, particularly in units with persistently high rates. Case review, therapeutic communication, early identification of financial or psychosocial barriers, patient education, and post-DAMA follow-up are more appropriate responses than interpreting early bed release as productive turnover.

VII. Limitations and Future Research

This study has several limitations. First, it is based on a single regional hospital and only seven cross-sectional units, which limits external generalization. Second, all variables are aggregated at unit-month level; the model does not capture individual patient severity, diagnosis, socioeconomic factors, or detailed case mix. Third, nursing staffing intensity and BOR are structurally related through patient census, creating potential endogeneity and requiring cautious interpretation of the negative staffing coefficient. Fourth, inference for ITK and DAMA is sensitive to the covariance estimator, and the ITK and LOS results are sensitive to adjustment for common time effects; the primary model did not include time effects, which were examined only as robustness analyses. PCSE is feasible with $N=7$ and $T=24$, but the finite time dimension constrains estimation of the contemporaneous covariance structure; cluster-robust inference is also imprecise with only seven clusters, a setting in which finite-cluster distortions are well documented [15], [16]. Fifth, standardized betas were computed from overall sample standard deviations rather than within-transformed standard deviations and therefore cannot be used as a fixed-effects ranking of predictor importance. Sixth, although the fixed-effects design controls time-invariant unit characteristics, it does not eliminate bias from time-varying omitted factors.

Future studies should extend the time horizon, include multiple hospitals, and incorporate demand-side variables such as monthly admissions, referral flows, seasonal disease patterns, bed closures, and case-mix indices. Replication with longer T and more units should compare PCSE, Driscoll-Kraay, and small-cluster-robust procedures using prespecified covariance choices. Dynamic panel approaches using lagged BOR or appropriate instrumental-variable/GMM strategies may help address simultaneity between staffing, census, and occupancy. Patient-level or episode-level analyses can also examine how clinical characteristics interact with LOS and DAMA before the data are aggregated to the ward level.

VIII. Conclusion

Panel evidence from seven inpatient units at Landak Regional Hospital shows that occupancy during 2024-2025 was characterized by low average utilization and substantial cross-unit heterogeneity. LOS did not have a significant association with BOR in the primary unit fixed-effects model, but it showed a positive within-unit association once common time effects were removed. Nursing staffing intensity was negatively associated with BOR and reached the 5% level under the primary PCSE specification, but this significance weakened under unit-clustered and Driscoll-Kraay sensitivity checks and disappeared after adjustment for common time effects; the association largely reflects hospital-wide growth in patient volume relative to nurse staffing and should not be interpreted as a robust or causal effect of nurse numbers. DAMA also showed a stable negative direction but estimator-sensitive significance. The three predictors were jointly significant under the primary model and remained jointly significant in the alternative covariance checks, while the large contribution of unit fixed effects indicates that occupancy management should be tailored to the structural characteristics of individual inpatient units. Effective capacity management at Landak Regional Hospital therefore requires unit-specific demand planning, responsive nursing allocation, and targeted reduction of DAMA rather than reliance on a single dominant operational predictor.

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