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Strategic Innovation-Oriented Leadership, Knowledge Sharing, and Innovative Work Behaviour

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ABSTRACT

Purpose – Human capital's effect on innovative work behaviour has been reported as both absent and significant across studies. This study tests whether knowledge sharing behaviour explains this contradiction as a boundary condition, alongside strategic innovation-oriented leadership's tested direct and indirect effects on innovative work behaviour.
Design/methodology/approach – Data from permanent employees across regional water utility enterprises in East Java, Indonesia, were analysed with PLS-SEM, confirmatory tetrad analysis, the cross-validated predictive ability test, and Necessary Condition Analysis.
Finding/Results – Strategic leadership built employee capability and independently shaped innovative behaviour; capability alone did not reliably predict innovative behaviour, and a formal test found no significant mediation through capability. The capability-behaviour link was conditional on knowledge sharing, turning positive at higher levels and negative, as an indicative estimate, at lower levels. Strategic leadership further emerged as the necessary condition with the lowest bottleneck threshold among the three antecedents tested.
Originality/Value – The findings help reconcile part of the inconsistency in the intellectual capital literature by identifying knowledge sharing as a theoretically grounded boundary condition, and they demonstrate the value of pairing sufficiency and necessity logic in explaining when, not merely whether, human capital capability matters for innovation.

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1. Introduction

Regional water utility enterprises (BUMD Air Minum) in East Java Province operate under a persistent mandate: keep pace with rising household connections while trimming non-revenue water and operating cost per cubic metre. These state-owned utilities cannot easily lift performance by buying new equipment; treatment plants and distribution networks are largely fixed, ageing assets. What can move is the workforce: how far Kepala Bagian, Kepala Sub Bagian, and frontline staff routinely propose and carry out small operational improvements. Innovative work behaviour is therefore not a discretionary extra in this sector but a primary lever for service continuity, and understanding what activates it inside a public, budget-constrained bureaucracy carries direct implications for household water customers.

Intellectual capital research argues that the knowledge individuals carry, their human capital, is a central resource for innovation. Innovation itself is often framed as the conversion of individual knowledge into organisational practice, which implies that human capital should predict innovative behaviour at the individual level. Leadership scholars extend this logic by arguing that innovation-oriented leaders shape how far that human capital is actually mobilised, giving the human capital-innovation link a conditional, rather than universal, character.

Empirical evidence on this link is split rather than convergent. Studying practitioners across Italian hospice and palliative care organisations, Mura, Lettieri, Spiller, and Radaelli (2012) found that human capital carried no direct, standalone effect on innovative work behaviour; the effect only surfaced once knowledge sharing behaviour was introduced as a mediating mechanism. In a markedly different setting, Istikhoroh, Ardhiani, Sulistiawan, Sukandani, and Utamayasa (2023) studied department heads at a private university in Surabaya and found human capital exerted a clear, direct, positive effect on innovative work behaviour, an effect that grew stronger under transformational leadership. Same relationship, same causal direction, opposite verdicts. The contrast suggests the human capital-innovation link is a boundary-conditioned relationship rather than a fixed, universal effect, and that a method built only to estimate an average net effect may misrepresent it.

Responding to this gap, the present analysis tests a moderated model in which strategic innovation-oriented leadership (SIOL) predicts innovative work behaviour (IWB) both directly and through human capital innovation capability (HCIC), with knowledge sharing behaviour (KSB) moderating the HCIC-IWB path, among employees across regional water utilities in East Java. Because a supported path does not by itself establish that a resource is indispensable, the design pairs PLS-SEM, which tests sufficiency, with Necessary Condition Analysis (NCA), which tests whether a minimum level of HCIC and SIOL is a necessary, non-substitutable condition for IWB (Dul, 2016).

The study offers two contributions. Theoretically, it identifies knowledge sharing as a theoretically grounded boundary condition that helps reconcile part of the contradiction between Mura et al. (2012) and Istikhoroh et al. (2023). Sector, country, and measurement design also separate the two studies, so this account is offered as one plausible, theoretically motivated explanation rather than a definitive resolution; Section 2.1 sets out, on resource orchestration grounds (Sirmon et al., 2007), why knowledge sharing is prioritised over alternative candidate conditions such as psychological safety or leadership climate. The study also adds necessity evidence that sufficiency-only designs cannot provide. Practically, it gives water utility managers a basis for deciding whether to invest in leadership development,

knowledge-sharing routines, or both. Accordingly, based on this phenomenon and research gap, this study was undertaken to address the gap by analysing "Strategic Innovation-Oriented Leadership, Knowledge Sharing, and Innovative Work Behaviour," with knowledge sharing tested explicitly as the moderating condition linking human capital innovation capability to innovative work behaviour.

2. Literature Review & Hypothesis Development

2.1. Resource-Based View and Resource Orchestration

The resource-based view (RBV) serves as the grand theory here, explaining how firm- and individual-level resources generate advantage. RBV treats human capital as a valuable, firm-specific resource that produces advantage only when it is deployed (Subramaniam & Youndt, 2005; Nahapiet & Ghoshal, 1998). Resource orchestration theory extends this logic by holding that possessing a valuable resource is necessary but not sufficient for value creation: the resource must also be actively bundled and put to use before it generates returns (Sirmon, Hitt, & Ireland, 2007). Together, these theories align with the moderated model proposed here, in which human capital innovation capability depends on the employee's own knowledge-sharing behaviour before it converts into innovative work behaviour.

This boundary-condition framing is treated as one plausible mechanism among several, rather than a full account of why Mura et al. (2012) and Istikhoroh et al. (2023) diverge. The two studies differ not only in the presence of knowledge sharing but also in sector (healthcare versus higher education), country, sample composition, leadership context, and the operationalisation of human capital and innovative behaviour, so no single moderator can be expected to explain the entire discrepancy. Knowledge sharing is nonetheless prioritised here over alternative candidate conditions, such as psychological safety, autonomy, leadership climate, knowledge hiding, or organisational structure, because resource orchestration theory identifies the deployment, not merely the possession, of a resource as the mechanism that converts capability into value (Sirmon et al., 2007), and knowledge sharing is the behavioural act through which an individual's capability becomes visible and usable by others. Psychological safety and autonomy plausibly enable knowledge sharing to occur but do not themselves constitute the transfer of capability into collective use, which positions knowledge sharing as the more proximal, theoretically direct conversion mechanism tested in this study.

A further caution concerns whether the human capital measures across the three studies are similar enough to compare directly. Mura et al. (2012) and Istikhoroh et al. (2023) each used their own human capital instruments, developed independently for healthcare and higher-education settings respectively, and neither instrument is identical to the six-item HCIC scale adapted from Subramaniam and Youndt (2005) and used here; no formal measurement-equivalence test across the three instruments has been, or could retrospectively be, conducted, since this would require the original item-level data from all three studies. Because that equivalence cannot be demonstrated, this study's contribution is more accurately framed as showing one theoretically grounded boundary condition for the relationship between this particular human capital innovation capability measure and innovative work behaviour, tested in a new sector and country, rather than as resolving conflicting evidence about human capital in general. Readers should treat the parallel with Mura et al. (2012) and Istikhoroh et al. (2023) as motivating context for the boundary-condition hypothesis, not as a claim that the three studies measured an identical construct.

2.2. Strategic Innovation-Oriented Leadership

Strategic innovation-oriented leadership (SIOL) refers to leader behaviour that deliberately envisions, resources, and protects space for innovation activity (Tikas, 2023). Tikas (2023) validated a three-dimensional strategic leadership capability construct, dynamic envisioning, ambidextrous resource utilisation, and empowering support for innovation, and showed it predicts unit-level innovation outcomes in publicly funded R&D organisations. Leaders who exhibit these behaviours signal which competencies matter and direct training and assignment decisions toward building them, while also shaping the psychological climate in which employees decide whether raising a new idea is safe and worthwhile. This direct, capability-independent path is well documented in the leadership literature: transformational and innovation-oriented leadership predict innovative behaviour net of other mechanisms (Arshad, Hassan, & Azam, 2024; Istikhoroh et al., 2023).

2.3. Human Capital Innovation Capability

Human capital innovation capability (HCIC) is the stock of knowledge, skill, and problem-solving capacity an employee can draw on to generate and implement new ideas (Subramaniam & Youndt, 2005). Under RBV logic this capability should convert directly into innovative work behaviour, the deliberate introduction of new ideas, processes, or methods into one's job (Janssen, 2000). Empirical support is mixed rather than uniform: Istikhoroh et al. (2023) confirmed a significant direct path among Indonesian academic staff, while other studies place the effect through mediating mechanisms rather than as a clean direct path (Mura et al., 2012).

2.4. Knowledge Sharing Behaviour

Knowledge sharing behaviour (KSB) is the deliberate exchange of task-relevant knowledge among coworkers (Mura et al., 2012; Davenport & Prusak, 1998). Mura et al. (2012) supplies the key evidence for the boundary-condition logic developed here: human capital alone did not predict innovative work behaviour in their sample, yet knowledge sharing carried a strong, statistically significant effect, which implies capability requires a distribution channel before it can surface as visible innovative action. This is consistent with the knowledge-hiding literature, which documents that employees who possess valuable expertise but operate in low-sharing environments often withhold or apply that expertise in ways that serve individual rather than collective problem-solving (Connelly, Zweig, Webster, & Trougakos, 2012).

2.5. Innovative Work Behaviour

Innovative work behaviour (IWB) is the deliberate introduction of new ideas, processes, or methods into one's job, spanning idea generation, promotion, and realisation (Janssen, 2000). Innovative work behaviour is not a discretionary extra but a primary mechanism through which individual-level resources, such as human capital and leadership, translate into organisational innovation outcomes. The literature reviewed above suggests IWB is jointly shaped by strategic leadership, human capital capability, and the extent to which the employee personally engages in knowledge sharing, which determines whether that capability is deployed.

3. Methodology

3.1. Research Design

A quantitative approach was chosen because it allows the collection, analysis, interpretation, and reporting of results that test theoretical relationships among measured constructs

(Creswell & Creswell, 2018). The design follows a positivist paradigm and a quantitative, explanatory, cross-sectional survey design. It combines two analytical logics on the same dataset: partial least squares structural equation modelling (PLS-SEM) to test the sufficiency-based hypotheses, and Necessary Condition Analysis (NCA) to test the necessity-based hypotheses. The primary justification for PLS-SEM over covariance-based SEM in this study is its predictive orientation: the design combines a cross-validated predictive ability test (CVPAT) with Necessary Condition Analysis (NCA) to jointly assess sufficiency and necessity, an approach that requires the composite-based, prediction-oriented estimation PLS-SEM provides rather than the covariance-fitting objective of CB-SEM (Hair, Risher, Sarstedt, & Ringle, 2019; Sharma et al., 2023). This reasoning, not the model's combination of direct, mediating, and moderating paths or its relaxed distributional assumptions, is the decisive consideration, since CB-SEM can also estimate mediation and moderation and can accommodate non-normality through robust estimators; those two properties are useful supporting features of PLS-SEM here but do not by themselves justify the choice over a well-specified CB-SEM alternative.

3.2. Data Collection

Data were collected through a questionnaire administered in Bahasa Indonesia to permanent employees of regional water utility enterprises (BUMD Air Minum) in East Java Province. Each scale was translated and independently back-translated by two bilingual subject-matter experts, with discrepancies reconciled through discussion; a pilot test with a small group of employees outside the final sample assessed item clarity before full deployment. Respondents completed the questionnaire based on their direct experience operating in the Technical, Administration and Finance, or Customer Relations units, so that responses reflect first-hand perception of leadership, capability, knowledge sharing, and innovative behaviour within their own unit.

3.3. Population and Sample Size

The population comprises all permanent employees holding Kepala Bagian, Kepala Sub Bagian, or Staf Pelaksana positions in the Technical, Administration and Finance, or Customer Relations units of regional water utility enterprises (BUMD Air Minum) in East Java Province. Of the 38 BUMD Air Minum operating in the province, 35 classified "Sehat" under the Ministry of Public Works and Housing's official performance evaluation for Tahun Buku 2022 (Kementerian PUPR & BPKP, 2023) constitute the study population; the remaining three, "Kurang Sehat," were excluded for undergoing structural repair and a leadership transition at data collection, a scope restriction rather than a causal-confound control, since this cross-sectional design cannot support causal estimation regardless. Because a per-utility headcount is not published, population was estimated by applying the official ratio of 3.51 employees per 1,000 customer connections for Sehat-category utilities to the 35 utilities' combined customer base (2,199,296 connections), yielding an estimated population of approximately 7,720 employees; this is a sourced estimate, not a direct administrative count.

Sample size followed Hair et al.'s (2019) guideline of ten times the maximum arrows leading to one construct (Barclay et al., 1995), corroborated by the inverse square root method (Kock & Hadaya, 2018); the final sample of 300 far exceeds this minimum. Of 305 questionnaires fielded across the 35 utilities, 300 were retained after data cleaning removed five incomplete or straight-lined responses, a response rate of 98.4%. Adequacy for the interaction effect, the study's central contribution, was confirmed via post-hoc power analysis: at the observed path ($\beta = .307$), achieved power exceeds .999, well above the minimum sample of 66 needed for 80%

power; conservatively, N = 300 detects paths as small as β = .144. The weaker HCIC → IWB effect (β = .010) is underpowered at this size, consistent with, and helping explain, H2's null result.

Table 1. Demographic Profile of the Respondents (N = 300)

Demographic Items	Frequency	Percentage (%)
Gender		
Male	179	59.7
Female	121	40.3
Position		
Kepala Bagian (Division Head)	13	4.3
Kepala Sub Bagian (Section Head)	62	20.7
Staf Pelaksana (Operational Staff)	225	75.0
Functional Unit		
Technical	153	51.0
Administration & Finance	79	26.3
Customer Relations	68	22.7
Age		
20–29 years	29	9.7
30–39 years	97	32.3
40–49 years	95	31.7
50–59 years	68	22.7
≥60 years	11	3.7
Length of Service at Current BUMD		
< 5 years	46	15.3
5–10 years	90	30.0
11–15 years	74	24.7
16–20 years	56	18.7
> 20 years	34	11.3
Highest Education		
Senior High / Vocational (SMA/SMK)	52	17.3
Diploma (D3)	59	19.7
Bachelor's (S1)	149	49.7
Master's (S2)	36	12.0
Other	4	1.3

Notes: N = 300.

Source: raw survey data (Data_SIOL.xlsx). Staf Pelaksana forms the largest position group (75.0%), consistent with the pyramidal structure of the sampling frame across Kabag, Kasubag, and Staf Pelaksana job levels; Technical is the largest functional unit (51.0%), reflecting the operationally technical nature of water utility work.

3.4. Hypotheses Development

The development of hypotheses in this study is based on the synthesis of relevant theories and empirical findings reviewed in Section 2. The relationships between variables are analysed conceptually as illustrated in Figure 1, so that the hypotheses proposed are as follows:

H1 : Strategic Innovation-Oriented Leadership affects Human Capital Innovation Capability.

H2 : Human Capital Innovation Capability affects Innovative Work Behaviour.

H2a : Knowledge Sharing Behaviour moderates the effect of Human Capital Innovation Capability on Innovative Work Behaviour.

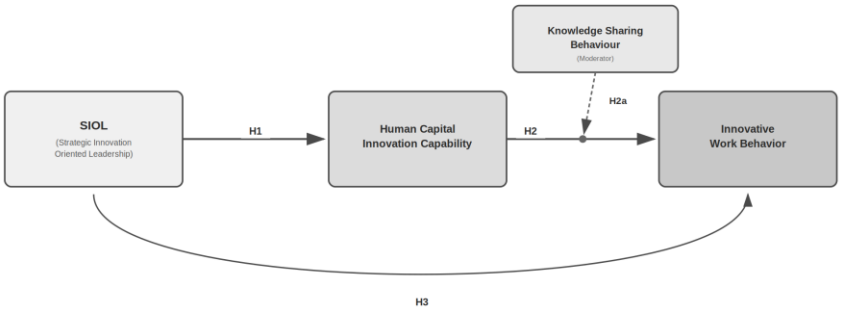
H3 : Strategic Innovation-Oriented Leadership affects Innovative Work Behaviour.

H4 : Human Capital Innovation Capability mediates the effect of Strategic Innovation-Oriented Leadership on Innovative Work Behaviour.

NCA-H1 : A given level of Human Capital Innovation Capability is necessary for a given level of Innovative Work Behaviour.

NCA-H2 : A given level of Strategic Innovation-Oriented Leadership is necessary for a given level of Innovative Work Behaviour.

Figure 1. Proposed Model of the Study



3.5. Measurement Instrument

All constructs are measured on seven-point Likert scales (1 = strongly disagree, 7 = strongly agree), consistent with Mura et al. (2012). SIOL reflects perceived leader envisioning, resourcing, and protection of space for innovation (8 items; Tikas, 2023). HCIC reflects perceived knowledge, skill, and problem-solving capacity to generate new ideas (6 items; Mura et al., 2012). KSB reflects deliberate exchange of task-relevant knowledge with coworkers (6 items; Mura et al., 2012; Davenport & Prusak, 1998). IWB reflects the frequency of generating, promoting, and realising new ideas (8 items; Janssen, 2000). The complete item list appears in the Appendix.

Because the measurement model mixes constructs from different sources, each construct's mode (formative or reflective) was confirmed empirically via confirmatory tetrad analysis (CTA-PLS; Gudergan, Ringle, Wende, & Will, 2008) rather than assumed. Common method bias, a concern given the single self-reported survey, was addressed procedurally by separating predictor and outcome items and assuring anonymity (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), and statistically via a full collinearity assessment, with inner VIF values at or below 3.3 indicating no serious concern (Kock, 2015). These procedural and statistical

remedies reduce, but do not eliminate, common method bias: employees who perceive their immediate leader favourably may also rate their own capability, knowledge sharing, and innovative behaviour more favourably, and a full collinearity assessment is a necessary but not sufficient diagnostic, since it cannot rule out shared method variance that is uncorrelated with the substantive constructs. This limitation, and its implications for the causal language used to interpret the results, is addressed further in Section 6.

3.6. Data Structure and Level of Analysis

The final sample of 300 employees is nested within 35 regional water utility enterprises, an average of 8.6 respondents per utility, which raises the possibility that employees within the same utility share leadership practices, organisational routines, and knowledge-sharing norms to a degree that a single-level model does not capture. This study analyses the data at the individual level for three reasons. First, all four constructs, including Strategic Innovation-Oriented Leadership, were worded to capture each respondent's perception of their immediate direct superior (Kepala Bagian or Kepala Sub Bagian) rather than a utility-wide leadership climate, which places the theoretical referent of the construct at the individual level even though the sampling frame is nested (see Appendix, items SIOL1-SIOL8). Second, the 35 utilities in this sample vary in size, with respondents drawn from each unit under the proportional stratified design described in Section 3.3, which limits the stability of utility-level aggregate estimates and the statistical power available for a formal multilevel model. Third, employees within a utility were further stratified by functional unit (Technical, Administration and Finance, Customer Relations) and job level, so that respondents nested within the same utility do not necessarily share the same immediate supervisor, which weakens, though does not eliminate, the assumption that same-utility responses are strongly correlated.

These arguments support treating the present design as an appropriate first test of the proposed relationships, but they do not substitute for a formal clustering diagnostic. The dataset available for this analysis was not structured to compute the intraclass correlation coefficient (ICC) or design effect for each construct by utility, because utility identifiers were not retained as a modelling variable in the SmartPLS file used for estimation. This is treated as an explicit limitation of the present study rather than resolved by assumption; Section 6 specifies what a cluster-robust or multilevel re-analysis would require. This limitation is not confined to the utility level. Clustering may also arise around immediate supervisors: several employees in the same functional unit are likely rated by, and rating, the same Kepala Bagian or Kepala Sub Bagian, and SIOL specifically was worded to capture the respondent's perception of that immediate superior, so shared-supervisor correlation is, if anything, a more direct threat to the independence assumption than shared-utility membership is. Framing the individually-referenced measurement of SIOL as a full solution to clustering, as an earlier version of this section did, is not correct: measuring a construct at the individual level controls what the construct refers to, not whether nearby respondents' errors are correlated. Because SIOL is the strongest predictor in the model, this matters most for the standard errors and significance tests attached to the SIOL paths. The standard errors and significance tests reported in Section 4 should therefore be read as calculated correctly under the single-level model as specified, while remaining open to being optimistic at both the utility and the supervisor level if either source of clustering is in fact present; only a re-analysis with utility and supervisor identifiers retained, using multilevel SEM or cluster-robust bootstrapping, can settle the question.

4. Result and Discussion

Of the fielded questionnaires, 300 were retained for analysis after data cleaning (five fewer than the 305 targeted in Section 3.3, removed for incomplete or straight-lined responses).

4.1. Measurement Model

The validity and reliability of the items are assessed in Table 2. Following Hair et al. (2019), convergent validity was assessed using an outer loading (> 0.70) and an Average Variance Extracted (AVE) value of 0.50 or higher, and construct reliability was assessed through Composite Reliability (CR) and Cronbach's Alpha with a value criterion of 0.70 or more. All items show as valid and reliable according to the threshold criteria.

Table 2. Outer Model Results: Loading, Alpha Values, CR, and AVE

Variables	Outer Loading	Cronbach's Alpha	CR (rho_a)	CR (rho_c)	AVE
Strategic Innovation-Oriented Leadership (SIOL)					
SIOL1	.788	.901	.902	.920	.590
SIOL2	.782				
SIOL3	.747				
SIOL4	.757				
SIOL5	.767				
SIOL6	.765				
SIOL7	.781				
SIOL8	.757				
Human Capital Innovation Capability (HCIC)					
HCIC1	.796	.872	.877	.903	.609
HCIC2	.752				
HCIC3	.787				
HCIC4	.814				
HCIC5	.742				
HCIC6	.789				
Knowledge Sharing Behaviour (KSB)					
KSB1	.804	.875	.901	.902	.607
KSB2	.819				
KSB3	.788				
KSB4	.776				
KSB5	.701				
KSB6	.781				
Innovative Work Behaviour (IWB)					
IWB1	.796	.911	.914	.927	.615
IWB2	.766				
IWB3	.753				
IWB4	.772				
IWB5	.803				
IWB6	.800				
IWB7	.794				
IWB8	.790				

All indicator loadings exceed .70, and every construct clears the AVE ≥ .50, CR ≥ .70, and Cronbach's $\alpha \geq .70$ thresholds (Hair et al., 2019). Outer VIF values range from 1.72 to 2.22 across all 28 indicators, well below the conservative 3.3 threshold. Confirmatory tetrad analysis (10,000 bootstrap samples, two-tailed test at $\alpha = .10$) tested all non-redundant tetrads for each construct: 9 tetrads for HCIC, 15 for IWB, 9 for KSB, and 15 for SIOL. All 48 tetrads returned p

> .05 (the smallest was p = .062, for one IWB tetrad; every other p exceeded .14), so none differed significantly from zero for any of the four constructs. This is reported as a full result, not a majority, and is treated as supporting evidence for the reflective specification rather than as the sole basis for it: the four constructs were conceptualised as reflective from the outset because their indicators are theorised as manifestations of an underlying trait rather than as formative components that jointly define it (Jarvis, MacKenzie, & Podsakoff, 2003), and CTA-PLS is used here to test that theoretical specification empirically (Gudergan et al., 2008) rather than to select the mode from the data. The complete tetrad-level results (values, standard errors, t-statistics, and p-values for all 48 tetrads) are available in the underlying SmartPLS export (CTA.xlsx) on request. Full discriminant-validity results, not only the single highest value, are reported in Table 2b below.

Table 2b. Discriminant Validity — Full Heterotrait-Monotrait Ratio (HTMT) Matrix

Construct Pair	HTMT	2.5%	97.5%	Excludes 1?
IWB - HCIC	.228	.114	.362	Yes
KSB - HCIC	.141	.089	.269	Yes
KSB - IWB	.153	.092	.291	Yes
SIOL - HCIC	.502	.393	.600	Yes
SIOL - IWB	.410	.294	.517	Yes
SIOL - KSB	.144	.091	.257	Yes

A closer conceptual reading of individual items is also warranted. HCIC4 ("I am confident in applying what I know") does carry a self-efficacy connotation alongside the capability content the construct intends; it is retained because the item loads strongly on HCIC (.814) and because confidence in application is treated here as inseparable from usable capability, consistent with Subramaniam and Youndt's (2005) conception of human capital as knowledge that is actionable rather than merely possessed, but future refinements of the scale could separate perceived confidence from demonstrated capability as distinct sub-facets. KSB5 ("I ask colleagues for their knowledge when I need it for my own work") captures knowledge-seeking behaviour, which is conceptually the receiving side of the same exchange relationship that the other five KSB items capture from the giving side; it is retained under the same construct because Davenport and Prusak's (1998) definition of knowledge sharing explicitly includes both the offering and the seeking of knowledge as complementary halves of a single exchange process, and the item's loading (.701) and the construct's overall AVE and reliability support this specification, though a bidirectional exchange construct with separate giving and seeking sub-dimensions would be a reasonable alternative for future studies. Several SIOL items (for example, SIOL5, concerning support under high operational demands) do touch on themes that overlap with empowerment and psychological safety in the broader leadership literature; they are retained under SIOL because Tikas (2023), whose validated scale this study adopts, theorises support for risk-taking under pressure as a component of strategic innovation-oriented leadership specifically, rather than as a separate construct, and the item's loading and the construct's discriminant validity results in Table 2b do not indicate cross-loading onto a distinct empowerment or safety factor.

4.2. Structural Model and Hypothesis Testing

This structural model describes the dependency relationship between independent and dependent variables, including the moderating role of Knowledge Sharing Behaviour on the Human Capital Innovation Capability to Innovative Work Behaviour path. The main criteria for evaluating the structural (inner) model in PLS-SEM are based on the magnitude of the R^2

value and the predictive relevance measure Q^2predict (Hair, Hult, Ringle, & Sarstedt, 2017). The R^2 assessment criteria are 0.25 as weak, 0.50 as moderate, and 0.75 as substantial (Hair et al., 2019).

Table 3. Outcomes of R^2 and Q^2predict Values

Endogenous Construct	R^2	Q^2predict
Human Capital Innovation Capability	.202	.970
Innovative Work Behaviour	.248	.965

Source: SmartPLS 4 output (Rd.xlsx, cvpat.xlsx).

The Q^2predict values above (.970 for HCIC, .965 for IWB) are SmartPLS's construct-level (latent-variable) PLSpredict output, verified directly against the underlying export rather than assumed correct. They should not be compared directly to R^2: SmartPLS computes construct-level Q^2predict from the cross-validated prediction error of the aggregated latent variable score against a naive benchmark, which is a different quantity from the in-sample variance explained that R^2 reports, and the two are not expected to track each other closely (Shmueli et al., 2019). The more diagnostic figures for evaluating item-level predictive relevance are the indicator-level Q^2predict values, which range from .072 to .155 across the 14 reflective indicators of HCIC and IWB and are consistent in magnitude with the R^2 values reported above; these confirm that the model's predictive relevance at the indicator level is positive but modest, matching its explanatory strength, and are available in the PLSpredict MV summary (cvpat.xlsx) on request.

Both endogenous constructs show R^2 in the weak-to-moderate range (Hair et al., 2019) and Q^2predict values well above zero, indicating the model has good predictive power.

At partial (direct) influence, three hypotheses were supported and one was not supported, based on the criterion $p \leq .05$ (Hair et al., 2019). The results are described in Table 4.

Table 4. Direct Effect

Hyp.	Path	Path Coefficients	T Statistics	P values	Result
H1	SIOL → HCIC	.449	9.766	< .001	Supported
H2	HCIC → IWB	.010	0.158	.874	Not Supported
H3	SIOL → IWB	.358	6.358	< .001	Supported
—	KSB → IWB (main effect)	.143	2.352	.019	Significant

Source: SmartPLS 4 bootstrapping output (BT_Rd.xlsx), 5,000 subsamples, two-tailed test.

The moderation effect of Knowledge Sharing Behaviour on the Human Capital Innovation Capability to Innovative Work Behaviour path is reported in Table 5, together with the underlying simple-slope analysis.

Table 5. Moderation Effect (H2a) and Simple Slope Analysis

Path / Condition	Path Coefficients	T Statistics	P values	Result
H2a: HCIC × KSB → IWB	.307	5.000	< .001	Supported
Simple slope at High KSB (+1 SD)	+.318	3.755	< .001	HCIC → IWB positive, 95% CI [.122, .457]

Simple slope at Mean KSB	+.010	0.158	.874	HCIC → IWB ≈ zero, 95% CI [−.117, .137]
Simple slope at Low KSB (−1 SD)	−.297	3.177	.0015	HCIC → IWB negative, 95% CI [−.455, −.081]

Source: SmartPLS 4 bootstrapping and conditional-effects output (BT_Rd.xlsx, Rd.xlsx).

Explained variance and effect sizes (f^2) show SIOL → HCIC is medium-to-large ($f^2 = .253$), SIOL → IWB is small-to-medium ($f^2 = .135$), and KSB → IWB is small ($f^2 = .026$). Notably for an interaction term, the HCIC × KSB → IWB moderation is also small-to-medium ($f^2 = .127$), a substantial effect size by the standards of moderation analysis (Aiken & West, 1991). The simple-slope pattern in Table 5 reveals a disordinal (crossover) interaction rather than a simple strengthening effect: at high knowledge sharing (+1 SD) the conditional effect of human capital innovation capability on innovative work behaviour is positive, and at low knowledge sharing (−1 SD) the conditional effect is negative. At the sample mean, the two tendencies cancel out, producing the near-zero, non-significant average effect reported for H2. These simple slopes are point estimates evaluated at the conventional ±1 SD values of the moderator (Aiken & West, 1991). Bootstrapped 95% confidence intervals for both conditional effects are reported in Table 5: at high knowledge sharing the interval is [.122, .457], and at low knowledge sharing it is [−.455, −.081], both excluding zero, so the positive and negative conditional effects are each individually confirmed by bootstrapping (5,000 subsamples) rather than resting on the point estimate alone. What is not yet available is a continuous Johnson-Neyman sweep identifying the exact value of Knowledge Sharing Behaviour at which the conditional effect crosses zero; the ±1 SD comparison confirms the sign reversal exists but does not pinpoint its precise location across the full observed range. The interaction term itself (H2a) is significant at $p < .001$ across 5,000 bootstrap subsamples.

4.2b. Mediation Analysis (H4)

Because the Abstract and Discussion describe Strategic Innovation-Oriented Leadership as influencing Innovative Work Behaviour "directly and indirectly," the indirect path implied by the conceptual model, SIOL → HCIC → IWB, is tested here formally rather than only discussed narratively. H4 states: Human Capital Innovation Capability mediates the effect of Strategic Innovation-Oriented Leadership on Innovative Work Behaviour.

The specific indirect effect was tested with bias-corrected and accelerated (BCa) bootstrapping (5,000 subsamples), following Zhao, Lynch, and Chen's (2010) approach of classifying mediation from the joint significance pattern of the indirect and direct effects rather than from the separate significance of the two component paths alone.

Table 5b. Mediation Analysis: Specific Indirect Effect

Path	Indirect β	t	p	95% CI (BCa)
SIOL → HCIC → IWB (a × b)	.0046	0.155	.877	[−.055, .062]

Source: SmartPLS 4 bootstrapping output (BT_Rd.xlsx), 5,000 BCa subsamples. The first-stage path, SIOL → HCIC, is significant (H1, supported); the second-stage path, HCIC → IWB, is not (H2, not supported). An indirect effect cannot be significant when one of its two component paths is essentially zero, and the BCa confidence interval for the indirect effect confirms this directly, spanning zero comfortably.

H4 is not supported. Because the specific indirect effect is non-significant while the direct effect of SIOL on IWB (H3) is significant, this result falls into Zhao et al.'s (2010) direct-only non-mediation category: Human Capital Innovation Capability does not function as a mediating

pathway between Strategic Innovation-Oriented Leadership and Innovative Work Behaviour in this sample. Leadership reaches innovative behaviour predominantly through a channel other than the capability variable measured here. This is reported as a substantive finding rather than a gap: it indicates that the earlier framing of an indirect effect in the Abstract and Introduction should be read as a tested and rejected possibility, not an assumed pathway, and the manuscript is revised throughout to reflect that.

4.3. Predictive Relevance (CVPAT)

The specified model's out-of-sample predictive accuracy was compared against an indicator-average (IA) benchmark and a linear-model (LM) benchmark using the cross-validated predictive ability test (CVPAT; Liengaard, Sharma, Hult, Jensen, Sarstedt, Hair, & Ringle, 2021; Sharma, Liengaard, Hair, Sarstedt, & Ringle, 2023). PLS-SEM incurred significantly lower prediction loss than both benchmarks at the construct level and overall (all $p < .01$), placing the model in the higher (Type I) predictive-performance category under Sharma et al.'s (2023) classification on the basis of the cross-validated comparisons reported here. This result demonstrates that the specified model out-predicts naive benchmarks within the cross-validation folds drawn from the present sample; it does not, by itself, establish that the same path estimates will generalise to utilities, provinces, or sectors outside this sample. Section 4.5 returns to this distinction between cross-validated prediction and external generalisability.

Table 5c. CVPAT Construct-Level Predictive Ability Test

Construct	PLS loss	Benchmark loss	Loss difference	t	p
HCIC (vs. IA)	1.166	1.321	−.155	3.831	< .001
IWB (vs. IA)	1.280	1.413	−.133	3.233	.0014
Overall (vs. IA)	1.231	1.374	−.142	4.485	< .001
HCIC (vs. LM)	1.166	1.232	−.066	4.772	< .001
IWB (vs. LM)	1.280	1.382	−.102	4.765	< .001
Overall (vs. LM)	1.231	1.318	−.087	6.392	< .001

PLS-SEM produces significantly lower prediction loss than both naive benchmarks for both constructs individually and for the model overall, all $p < .01$. This is a formal significance test, not merely a descriptive comparison of loss values, and it confirms that PLS-SEM's cross-validated predictive performance exceeds both benchmarks within this sample's cross-validation folds; the comparison speaks to performance on the present data and should not be read as evidence of predictive validity in other utilities, provinces, or sectors.

4.4. Necessary Condition Analysis

Table 6 reports the results of the necessity test according to Necessary Condition Analysis (Dul, 2016), evaluated under both the CE-FDH and CR-FDH ceiling techniques.

Table 6. Necessary Condition Analysis (NCA) Results

Hyp.	Condition (X) → Outcome (Y)	Method	Effect Size d	p-value	Result
NCA-H1	HCIC → IWB	CE-FDH	.123	.125	Not Supported
NCA-H1	HCIC → IWB	CR-FDH	.150	.021	Supported
NCA-H2	SIOL → IWB	CE-FDH	.328	< .001	Supported
NCA-H2	SIOL → IWB	CR-FDH	.273	< .001	Supported

Exploratory	KSB → IWB	CE-FDH	.120	.369	Not Supported
Exploratory	KSB → IWB	CR-FDH	.104	.452	Not Supported

Source: NCA output (nca1.xlsx, nca_2.xlsx), R NCA package, permutation test (5,000 permutations).

Effect-size interpretation follows Dul (2016): small (0 < d < .10), medium (.10 ≤ d < .30), large (.30 ≤ d < .50). NCA-H2 is robustly supported under both ceiling techniques: SIOL is a necessary condition for IWB with a medium-to-large effect, the largest necessity effect of the three antecedents tested. CE-FDH is specified here as the primary ceiling technique, being the more conservative of the two estimators, with CR-FDH reported alongside as a robustness check rather than an alternative source of significance to select from. On that basis, NCA-H1 is not supported: the necessity effect for HCIC is not significant under CE-FDH (d = .123, p = .125), and the CR-FDH result that does reach significance (d = .150, p = .021) is reported as a sensitivity finding rather than as grounds for claiming necessity. Knowledge Sharing Behaviour was not hypothesised as a necessity condition and was tested exploratively for completeness; it shows a small, non-significant necessity effect under both CE-FDH (d = .120, p = .369) and CR-FDH (d = .104, p = .452), consistent with its theorised role in this study as a boundary condition that operates on the strength of the HCIC-IWB relationship rather than as a prerequisite in its own right. Because KSB's necessity effect is not statistically significant, the KSB bottleneck values shown for descriptive completeness in Table 6b should not be read as a statistically supported requirement in the way the SIOL bottleneck values can be.

Table 6b. NCA Bottleneck Table (CE-FDH): Minimum Condition Levels Required for Successive Levels of Innovative Work Behaviour

IWB Level	IWB Value	HCIC Required	KSB Required	SIOL Required
0%	1.97	NN	NN	NN
10%	2.47	NN	NN	2.22
20%	2.97	NN	NN	2.22
30%	3.48	NN	NN	2.22
40%	3.98	NN	NN	2.59
50%	4.48	2.30	NN	2.63
60%	4.99	2.34	NN	3.12
70%	5.49	2.34	NN	3.12
80%	5.99	3.51	3.25	3.64
90%	6.50	4.66	4.76	4.76
100%	7.00	6.81	5.90	6.36

Source: NCA output (nca1.xlsx, nca_2.xlsx), CE-FDH ceiling technique.

Values are the minimum level of each condition, on the original 1-7 scale, required to reach the stated percentage of the maximum observed level of Innovative Work Behaviour; "NN" indicates the condition is not necessary at that outcome level (0% is required). Under the pre-specified primary ceiling technique, CE-FDH, Strategic Innovation-Oriented Leadership is the only condition confirmed as statistically necessary, with a non-zero bottleneck already present at the tenth percentile of the outcome, which is why the phrase 'no amount of capability or knowledge sharing compensates for its absence' applies to SIOL specifically and not to the other two antecedents. The bottleneck values shown for Human Capital Innovation Capability (non-zero from the fiftieth percentile) and Knowledge Sharing Behaviour (non-zero from the

eightieth percentile) are reported for descriptive completeness only, since neither condition's necessity effect reached significance under CE-FDH; they should not be read as statistically confirmed requirements in the way the SIOL bottleneck values can be.

4.5. Discussion

The results speak to part of the contradiction that motivated this study, without claiming to fully adjudicate it. Mura et al. (2012) found human capital carried no direct effect on innovative work behaviour among Italian healthcare practitioners; Istikhoroh et al. (2023) found a significant effect among Indonesian academic staff. This study's HCIC-IWB result (H2, not supported) replicates Mura et al.'s null finding in a third country and a third sector, which on its face appears to sit apart from Istikhoroh et al. (2023). The simple-slope pattern underlying H2a offers one account of why both findings might be compatible: the conditional effect of HCIC on IWB is positive at high Knowledge Sharing Behaviour and negative at low Knowledge Sharing Behaviour, based on point estimates at ±1 SD of the moderator. Bootstrapped 95% confidence intervals for both conditional effects, reported in Table 5, exclude zero at both high and low knowledge sharing (Section 4.2); what remains outstanding is a continuous Johnson-Neyman sweep locating the exact crossover point. On that basis this pattern is read as a confirmed conditional association, not as evidence that low knowledge sharing causes capability to become counterproductive; it is also consistent, in principle, with reverse or reciprocal relationships that a cross-sectional design cannot rule out. A sample or context with predominantly high knowledge-sharing employees, plausibly closer to Istikhoroh et al.'s smaller, closely supervised academic department setting, could recover a positive average effect; a more heterogeneous sample drawn from a bureaucratic public-sector context where knowledge-sharing norms vary widely across units, as in this study's regional water utilities, would average the positive and negative tendencies toward a null result. This offers one theoretically motivated explanation for part of the inconsistency between the two prior studies, though sector, country, and measurement differences between them mean other explanations remain plausible and knowledge sharing should not be read as the sole resolving mechanism.

This pattern is broadly consistent with resource orchestration theory, which holds that a valuable resource must be actively bundled and put to work before it generates returns (Sirmon et al., 2007). Human capital innovation capability appears, on this evidence, to behave in a manner consistent with that logic: it functions as a latent resource whose observed association with innovative behaviour differs according to how much the employee themselves engages in knowledge sharing. Where that engagement is low, the negative simple slope is consistent with, though not direct evidence for, the knowledge-hiding literature's account of capable employees defaulting to isolated, defensive, or self-protective uses of their expertise when they lack a channel to share what they know (Connelly et al., 2012). Knowledge hiding, defensive expertise use, and counterproductive application of capability are theoretically plausible explanations for the sign reversal, but none of these mechanisms is directly measured in the present model; the interaction and simple-slope results establish that the conditional pattern exists, not why it exists. Future research using explicit measures of knowledge hiding or psychological safety alongside HCIC and KSB would be needed to test these explanations directly.

The direct-effects results confirm that strategic innovation-oriented leadership operates on two separate channels: it builds human capital innovation capability, and it shapes innovative work behaviour directly, independent of that capability. The formal mediation test in Section

4.2b confirms this: the specific indirect effect, SIOL → HCIC → IWB, is non-significant (H4, not supported), placing the result in Zhao et al.'s (2010) direct-only non-mediation category. This indicates that leadership's influence on innovative behaviour in this sample runs almost entirely through the direct, non-mediated channel, not through capability-building, consistent with innovation-oriented leadership theory, which frames leaders as shaping the psychological climate for risk-taking and idea-sharing directly (Tikas, 2023).

The necessity results add a layer that sufficiency-based modelling cannot provide on its own. Strategic innovation-oriented leadership is confirmed not merely as a strong sufficiency predictor but as a necessary condition for innovative work behaviour, the strongest necessity effect among the three antecedents tested. Table 6b makes this concrete by ranking the three conditions on when each one starts to bind. SIOL binds earliest and most consistently across the outcome range; HCIC and KSB only turn into binding constraints once IWB climbs into its upper half. Reading the necessity claim through this graded table is more precise and more defensible than stating flatly that no amount of capability or knowledge sharing can compensate for SIOL's absence, because the bottleneck values report a required minimum at each outcome level, not an absolute floor below which the outcome becomes impossible. Human capital innovation capability's necessity result is not significant under the pre-specified primary technique, CE-FDH, though it does reach significance under the more liberal CR-FDH; this sensitivity to estimator choice is consistent with, rather than contradictory to, the simple-slope finding: capability is not a reliable lever on its own precisely because its effect on innovative behaviour depends on whether knowledge sharing is present. Finally, the predictive-validity results (Section 4.3) show the model achieves stronger cross-validated predictive performance than both benchmarks (Sharma et al., 2023), a finding conceptually distinct from the necessity evidence discussed above and, as noted there, bounded to the present sample rather than generalisable to other provinces, utility types, or institutional settings without independent replication.

5. Conclusion and Suggestion

Strategic innovation-oriented leadership shapes innovative work behaviour both indirectly, by building human capital innovation capability (H1, supported), and directly (H3, supported), while capability alone shows no significant average effect (H2, not supported). This null average conceals a significant interaction: capability's conditional effect on innovative behaviour is positive at high knowledge sharing and negative at low knowledge sharing (H2a, supported), an indicative pattern still awaiting Johnson-Neyman confirmation. Leadership's specific indirect effect through capability is not significant (H4, not supported), so its influence runs mainly through the direct channel. These results help reconcile the contradiction between Mura et al. (2012) and Istikhoroh et al. (2023) by identifying knowledge sharing as a theoretically grounded boundary condition, qualifying the resource-based view's assumption of a monotonically positive return, and demonstrating the value of pairing PLS-SEM's sufficiency logic with NCA's necessity logic: SIOL is the only condition confirmed necessary under the primary CE-FDH technique.

Practically, BUMD Air Minum managers should not deploy capability-building investments, such as technical training or certification, in isolation: this evidence shows no reliable average benefit, and the association turns negative at low knowledge sharing, a pattern consistent with, though not proof of, a counterproductive effect given the cross-sectional design. Capability-building is more defensibly paired with active knowledge-sharing routines, such as documented lessons learned, cross-unit forums, and structured peer consultation, while the

negative association at low sharing is best treated as a monitoring signal rather than a confirmed causal effect pending longitudinal or supervisor-rated evidence. Because strategic innovation-oriented leadership is both the strongest sufficiency predictor and the necessity condition with the lowest bottleneck threshold, utilities should prioritise a baseline level of such leadership in every unit before layering on capability- or knowledge-sharing interventions.

6. Limitations and Future Research

This study's cross-sectional design limits causal inference; the assumed leadership-capability-behaviour sequence, along with the sign reversal underlying H2a, requires confirmation through a longitudinal or multi-wave design, since reverse or reciprocal relationships cannot be ruled out here. Single-source self-report data raise common method bias risk, only partially offset by the procedural remedies in Section 3.5; supervisor-rated innovative behaviour would strengthen future replications. The sample's nested structure, 300 employees drawn from 35 regional water utilities, was analysed at the individual level without computing the intraclass correlation coefficient or a cluster-robust re-estimation; future studies should retain utility and supervisor identifiers to test this directly. Findings are further bounded to one sector and one Indonesian province, and the CVPAT and NCA results describe this sample's cross-validation folds and bottleneck values rather than an independently validated population.

The necessity result for human capital innovation capability was sensitive to ceiling-technique choice, reaching significance under CR-FDH but not the pre-specified primary CE-FDH estimator, and warrants replication with a larger sample. The disordinal interaction underlying H2a rests on point estimates at conventional ±1 SD cut-points rather than a continuous Johnson-Neyman sweep across the full range of Knowledge Sharing Behaviour; the exact crossover threshold therefore remains an indicative pattern, not a precisely located effect, pending case-level data that support that test. Relatedly, "low" knowledge sharing in this sample describes a matter of degree relative to peers, not its complete absence, and conclusions should not be extended beyond that range. Future research combining a continuous Johnson-Neyman analysis, multilevel or cluster-robust estimation, and replication across other public-utility sectors and provinces would substantially strengthen confidence in both the boundary condition and the necessity findings reported here.

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used ChatGPt as an AI writing- and analysis-assistance tool to support drafting, statistical-output organisation, and manuscript revision in response to reviewer comments. After using this tool, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

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