



Dynamic Capabilities in Post-Restructuring Regional Water Utility Performance

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Abstract

Background: Public water utilities must maintain affordable and reliable services while managing financial constraints, aging infrastructure, and persistent non-revenue water following restructuring. These challenges are particularly important for regional water utilities operating as natural monopolies with simultaneous public-service and commercial mandates.

Objective: This study examines the associations among asset optimization, administrative customer loyalty, dynamic-capability proxies, and post-restructuring organizational performance.

Methods: A comparative longitudinal quantitative design combined exploratory structural equation modeling using partial least squares (SEM-PLS) with 108 branch-year records from 12 PDAM Jember service units observed during 2011–2019 and descriptive analysis of *Perumda Tirta Moedal Semarang* performance data for 2017–2024. Because the branch-year records represent repeated observations and the Semarang series lacks a preregistration baseline and comparison group, the findings are interpreted as structural associations and descriptive patterns rather than causal effects.

Results: In Jember, asset optimization was positively associated with administrative customer loyalty, dynamic-capability proxies, and organizational performance. The two indirect effects were significant, with a combined indirect effect of 0.582 and a combined variance accounted for (VAF) of 59.4%, indicating complementary partial mediation. In Semarang, long-term debt remained low and billing effectiveness exceeded 95%, while non-revenue water (NRW) remained between 28% and 38%. Springate values for 2017–2020 were researcher estimates, whereas the 2021–2024 values were based on available audited data.

Conclusion: The two cases provide a corroborative, but not statistically equivalent, pattern showing that financial recovery should be accompanied by workforce capability development, disciplined asset management, and monitored NRW reduction.

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INTRODUCTION

Globally, public water utilities face a persistent sustainability problem: they must maintain affordable and reliable services while controlling non-revenue water (NRW), financing aging infrastructure, and improving operational efficiency under constrained tariffs and public budgets. These pressures are especially consequential for utilities that operate as natural monopolies because weak performance cannot be corrected through ordinary customer switching or competitive exit. In Indonesia, Regionally Owned Enterprises (BUMDs) in the drinking water sector carry a dual social-commercial mandate under Law Number 23 of 2014 and Government Regulation Number 54 of 2017: they must provide affordable public services while operating professionally and contributing to Regional Original Revenue. The tension is therefore

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assessed empirically through service continuity, financial health, NRW, and resource-use efficiency rather than treated solely as a normative contradiction.

The scale of this problem is nationally documented. The 2022 joint performance evaluation by the Directorate General of Cipta Karya and BPKP—the latest comparable national dataset available to this study—classified 60.93% (237) of drinking water BUMDs as healthy, 25.96% (101) as unhealthy, and 13.11% (51) as sick ([Ministry of Finance of the Republic of Indonesia, 2023](#)). Low performance is associated with high NRW and weak customer-payment compliance, while national NRW remains above 30%. The wide variation in recovery speed after national debt restructuring is therefore not merely administrative; it leaves unresolved how utilities with different resource endowments convert financial relief and physical assets into durable operational performance. What organizational mechanisms enable that conversion?

This study compares two author-defined analytical recovery categories. “Gradual internal recovery” denotes improvement pursued through recurring branch-level asset and NRW management without an equivalent one-time non-cash capital injection; this classification of PDAM Jember for 2011–2019 is derived from the audited BPKP performance reports and Ministry of PUPR performance records used as the study dataset. “Debt-conversion recovery” denotes a discrete balance-sheet intervention followed by expanded investment capacity; in Semarang, Regional Regulation Number 10 of 2016 converted IDR 656.4 billion of central-government debt into non-cash government equity participation. These labels are descriptive criteria for comparing trajectories, not concepts adopted from prior theory. Because the observation periods differ and encompass distinct regulatory, macroeconomic, and COVID-19 conditions, cross-case comparisons are interpreted cautiously, and these factors are treated as potential confounders.

The contrast raises a theoretical question: is post-restructuring performance determined mainly by physical resources, or by the organizational capacity to reconfigure them? Resource-Based Theory (RBT) links valuable and well-organized resources to sustained advantage (Barney & Clark [\(2007\)](#), whereas Dynamic Capabilities Theory explains how resources are renewed as conditions change ([Teece & Pisano, 1994](#); [Teece, 2022](#)). In a natural-monopoly public utility, “advantage” is not interpreted as defeating competitors. Instead, it is translated into sustained service performance: operational resilience, financial viability, service continuity, and efficient use of assets under a dual social-commercial mandate.

The theoretical tension concerns whether dynamic capabilities remain relevant when competitive pressure and customer switching are largely absent. This study therefore examines the proposition that, in a drinking water BUMD, fiscal and regulatory shocks and the dual social-commercial mandate may function as triggers for sensing, seizing, and transforming resources. Rather than assuming that dynamic capability “mutates,” the analysis tests whether its role shifts from market competition toward maintaining service sustainability and operational resilience after restructuring.

The demand side presents a separate complexity. Because customers of a natural monopoly cannot readily switch providers, conventional choice-based loyalty is not directly applicable. Evidence that service quality and satisfaction shape behavioral outcomes Al-Jazzazi [\(2017\)](#) and Pakurár et al. [\(2019\)](#) and that satisfaction can reduce operating costs in monopoly utilities supports the use of administrative behavioral indicators. Nevertheless, billing effectiveness and connection growth may reflect captive-customer compliance rather than attitudinal loyalty. Accordingly, this study uses the narrower term “administrative customer loyalty/compliance” and does not claim to measure voluntary psychological loyalty.

The literature mapping in Table 1 identifies three connected gaps. Indonesian PDAM studies generally examine financial and operational determinants within single entities, whereas work on resources, intangible assets, technical capabilities, and dynamic capabilities largely concerns competitive firms ([Chumaidiyah, 2012](#); [Ocak & Findik, 2019](#); [Teece, 2022](#)). Research on restructuring primarily emphasizes balance-sheet effects, and research on monopoly utilities emphasizes customer-cost mechanisms ([Bhattacharya et al., 2021](#)). These streams have rarely been connected through a branch-level structural model accompanied by a longitudinal comparator case.

Table 1
Mapping of Previous Research and Research Novelty Positions

Research Flow	Previous Studies	Focus & Method	Limitations / Gaps	Position of this research
Determinants of BUMD/PDAM performance of drinking water	(Mintarti, 2012)	Financial-operational determinants; <i>cross-sectional</i> and partial on a single entity	Not comparing recovery trajectories; Mediation mechanism has not been tested	Testing a mediation structural model across two recovery trajectories (organic financial engineering) vs.
Integration of <i>Resource-Based Theory-Dynamic Capabilities</i>	(Kruesi & Bazelmans 2023; Teece, 2022)	Private companies in competitive markets; Capability Trigger = Market Competition	Has not been tested on a dual social-commercial mandate public natural monopoly	Expanding the integration of RBT-DC to public monopolies; Dynamic capability triggers = fiscal-regulatory shocks
Monopoly utility customer loyalty	(Bhattacharya et al., 2021)	Monopoly utilities of developed countries; Loyalty Increases Profits Through Cost Suppression	Has not been tested on developing country institutions; has not been integrated into the BUMD performance model	Operationalizing administrative loyalty and validating it to BUMDs in developing countries
Debt restructuring & <i>debt-to-equity swap</i>	(Frantz, 2019)	Macro panels; <i>balance-sheet effect</i> aggregate	Rarely triangulate granular structural models with longitudinal comparator cases	Eight-year audited branch-level and longitudinal SEM-PLS triangulation (Springate)

Source: Researcher's synthesis of previous literature (2018–2026).

Globally, public water utilities face a persistent sustainability problem. Starting from the empirical contrast between the two cases, the theoretical tension surrounding the application of dynamic capabilities to public monopolies, and the research gaps mapped in Table 1, this study formulates three research questions:

- RQ1: How do asset optimization and customer loyalty affect the performance of post-restructuring drinking water BUMDs?
- RQ2: To what extent do dynamic capabilities mediate the influence of asset optimization on performance?
- RQ3: Do gradual internal recovery and debt-conversion recovery exhibit corroborative post-restructuring performance patterns?
- Hypothesis development. RBT predicts that more effective use of production and distribution assets supports administrative customer loyalty and organizational performance; capability theory further predicts that asset resources support workforce renewal and that renewed capabilities improve performance. Accordingly, H1 states that asset optimization is positively associated with administrative customer loyalty; H2 states that asset optimization is

positively associated with company performance; H3 states that asset optimization is positively associated with dynamic capabilities; H4 states that administrative customer loyalty is positively associated with company performance; H5 states that dynamic capabilities are positively associated with company performance; H6 states that dynamic capabilities mediate the relationship between asset optimization and performance; and H7 states that administrative customer loyalty mediates the relationship between asset optimization and performance (Teece, 2022).

Based on the literature reviewed, this study offers a three-level contribution. Theoretically, it connects RBT, dynamic capabilities, and administrative customer loyalty within a single framework and examines fiscal-regulatory shocks as a possible trigger of dynamic capabilities. Contextually, it applies this framework to state-owned natural-monopoly utilities with dual social and commercial mandates. Methodologically, it compares branch-level structural associations with post-restructuring longitudinal patterns. These contributions are presented as a contextual integration rather than an unsupported claim that this is the first study of its kind.

At the contextual level, this study examines drinking water BUMDs as dual-mandate natural-monopoly organizations and assesses whether administrative customer loyalty and human-capital capability proxies are associated with post-restructuring performance. Methodologically, it juxtaposes exploratory branch-level SEM-PLS evidence from Jember with descriptive longitudinal evidence from Semarang. Given the different data structures and inferential strengths of the two cases, the study seeks a corroborative pattern rather than claiming a common mechanism that has been statistically validated across both cases.

METHOD

This study used a comparative-longitudinal quantitative design and analytical triangulation to examine two post-restructuring recovery patterns in drinking water BUMDs that pursued different strategies.

The analytical techniques differ because the data structures and research questions differ. The Jember case examines structural associations and mediation among variables across 12 service units using SEM-PLS, whereas the Semarang case describes audited post-restructuring performance patterns over time. Neither design provides experimental or quasi-experimental identification; consequently, the study does not infer policy causality. The two analyses are used for analytical triangulation: the Semarang trend evidence can corroborate, but cannot statistically validate or replicate, the structural relationships identified in the Jember case.

The concept of triangulation here is interpreted specifically. Following Denzin (2017), this study applied between-method methodological triangulation by combining two different analytical strategies (structural modeling and longitudinal tracing) to reduce the intrinsic bias inherent in reliance on a single method. Meanwhile, in the sense of Yin (2018), this study seeks convergence of evidence, which occurs when findings from different sources and techniques corroborate one another regarding a theoretical conclusion, thereby strengthening construct validity in case study research. The difference in emphasis between the two is complementary—Denzin highlights the combination of methods as an antidote to bias, whereas Yin emphasizes cross-evidence convergence as a means of reinforcing validity—and this study adopts both simultaneously.

Case 1 used SEM-PLS in SmartPLS to estimate direct and indirect structural associations from 12 PDAM Jember service units observed during 2011–2019 (108 branch-year records). These records are repeated observations, not 108 fully independent sampling units. Because the analysis did not apply clustered standard errors, multilevel estimation, or an explicit correction for temporal dependence, statistical significance is interpreted as exploratory and potentially optimistic. Collinearity and discriminant-validity checks reduce construct overlap but do not eliminate intrabranh correlation, year effects, or dependence arising from shared corporate policies.

Given that the data comprise repeated annual observations nested within 12 service units, a multilevel model would ordinarily be considered. However, the number of service units was insufficient for stable estimation at the branch level. Therefore, the available branch-year records were analyzed using pooled SEM-PLS as an exploratory analytical approach. This decision does not eliminate intrabranh correlation, temporal dependence, year effects, or shared corporate-

policy effects. Accordingly, the resulting coefficients and significance levels are interpreted as exploratory structural associations rather than cluster-adjusted or causal estimates.

Case 2 was analyzed descriptively using audited BPKP performance reports for 2017–2024 following the 2016 debt-to-equity swap. Because no pre-2016 baseline or untreated comparison group was available, this series identifies post-restructuring performance patterns only and cannot isolate the causal effect of the policy.

The use of service units/branches as the unit of analysis in Case 1 is theoretically justified from the perspective of the microfoundations of dynamic capabilities as developed. Drinking water BUMD service units in Indonesia—especially in large districts such as Jember—have a degree of semi-autonomous operational authority in managing local physical assets (distribution networks, reservoirs, and zone pump pressure), organizing billing, and responding to technical complaints from local customers. Therefore, the capacity for adaptation, the accumulation of technical competence, and the intensity of staff knowledge renewal at the branch level are not merely passive implementations of head-office policies but rather grassroots manifestations of the corporation's dynamic capabilities. Cross-branch variation in dynamic capability indicators reflects meaningful heterogeneity in the execution of organizational routines in the field; therefore, the branch level is a legitimate locus of analysis for capturing these microfoundations. To mitigate potential interbranch structural dependencies arising from head-office policies, the model includes checks for collinearity (VIF) and discriminant validity (HTMT), while the interpretation of the findings is directed toward cross-unit aggregate patterns rather than causal claims about individual branches.

The research population comprised drinking water BUMDs in Indonesia that had undergone financial restructuring. The Jember and Semarang cases were selected purposively based on three criteria: completion of a formal restructuring process, availability of performance data during the observation period, and representation of contrasting recovery trajectories. The primary data sources were BPKP performance evaluation reports and Ministry of PUPR drinking water BUMD performance records. The Springate values for Semarang in 2017–2020 were reconstructed estimates and were therefore treated separately from the available audited values for 2021–2024.

The two entities were selected as contrasting cases. Perumda Air Minum Tirta Moedal represents an urban water utility that underwent debt conversion through noncash government equity participation in 2016, whereas PDAM Jember represents a district water utility whose recovery relied primarily on gradual internal asset and NRW management without an equivalent capital injection. The comparison is intended to identify whether the two trajectories exhibit corroborative performance patterns rather than to establish statistically equivalent recovery mechanisms.

The purposive selection of two contrasting cases supports analytical comparison but does not provide statistical representativeness. Consistent with case-based analytical generalization, the findings are used to refine the proposed relationships among resources, capability proxies, administrative customer compliance, and organizational performance. Generalization to other drinking water BUMDs therefore requires replication across additional utilities and observation periods.

The operationalization of the research variables is presented in Table 2.

Table 2
Operationalization of Research Variables

Variable	Dimensions/Indicators	Operational Definition	Standard Source
Asset Optimization (X1)	<i>Production Efficiency</i> (X1.1); <i>Distribution Efficiency/NRW</i> (X1.2)	The ratio of real production volume to installed capacity of the installation; the percentage of distributed water that does not generate income (physical and non-physical losses).	BPPSPAM; PUPR

Customer Loyalty (Y1)	<i>Technical Service</i> (Y1.1); <i>Customer Growth</i> (Y1.2); <i>Billing Effectiveness</i> (Y1.3)	Speed of response to technical complaints; the percentage of organic addition of new house connections; The ratio of account payment receipts to total bills.	BPKP; (Bhattacharya et al., 2021)
Dynamic Capabilities (Y2)	<i>employee ratio</i> (Y2.1); <i>employee training ratio</i> (Y2.2); <i>Training Cost Ratio</i> (Y2.3)	Ratio of number of employees per 1,000 customers; the percentage of employees who attend functional training per year; The allocation of the training budget to the total burden of employees.	PERPAMSI; (Shujahat et al., 2019)
Company Performance (Y3)	Financial & Operational Performance; Springate S-Score	ROE, <i>Operating Ratio</i> , <i>Cash Ratio</i> ; $S = 1.03A + 3.07B + 0.66C + 0.40D$ (healthy if $S > 0.862$).	Ministry of Home Affairs 47/1999; (Springate, 1978)

Source: Compilation of researchers based on measurement standards BPPSPAM/PUPR, BPKP, PERPAMSI, Kepmendagri 47/1999, and reference literature.

Dynamic capabilities are operationalized here through administrative human-capital investment proxies (employee adequacy, training participation, and training expenditure). These indicators capture enabling inputs for capability renewal rather than the full sensing-seizing-transforming construct. Results are therefore interpreted at this narrower proxy level.

The Springate (1978) bankruptcy prediction model underlying the measurement of going-concern status for the Company Performance variable is formulated using the following equation:

$$S = 1.03A + 3.07B + 0.66C + 0.40D$$

where S is the Springate score; A is the ratio of working capital to total assets (Working Capital/Total Assets); B is the ratio of earnings before interest and taxes to total assets (EBIT/Total Assets); C is the ratio of profit before tax to current liabilities (Profit Before Tax/Current Liabilities); and D is the ratio of sales to total assets (Sales/Total Assets). The safe threshold (non-distress) is defined as an S value > 0.862 .

The analysis of Case 1 data was conducted in two stages following the standard PLS-SEM procedure. First, the measurement model (outer model) was evaluated by assessing convergent validity through outer loadings (threshold ≥ 0.70) and average variance extracted (AVE ≥ 0.50), construct reliability through composite reliability (CR ≥ 0.70), and discriminant validity through the heterotrait-monotrait ratio (HTMT ≤ 0.85), following the criteria of Hair et al. (2021). Second, the structural model (inner model) was evaluated by assessing collinearity (VIF < 5), the coefficient of determination (R^2), predictive relevance ($Q^2 > 0$), effect size (f^2), and model fit (SRMR < 0.08). The significance of the path coefficients was assessed through bootstrapping with 5,000 subsamples, using a two-tailed criterion of $t > 1.96$ and $p < 0.05$.

The mediation hypotheses (H6 and H7) were assessed using bootstrap-based specific indirect effects with 95% bias-corrected confidence intervals. An indirect effect was considered significant when its confidence interval did not include zero. For the parallel mediation model, the combined VAF was calculated by dividing the sum of the two indirect effects by the total effect. In Case 2, the Springate analysis covered 2017–2024; the 2017–2020 values were researcher estimates reconstructed from the available financial trends, whereas the 2021–2024 values were derived from the available audited data.

RESULTS AND DISCUSSION

Results

Evaluation of Measurement Model (Outer Model) — Case of PDAM Jember

Before testing the hypotheses, an evaluation of the outer model was conducted to ensure that all constructs met the criteria for validity and reliability. The test results are presented in Tables 3 and 4.

Table 3

Convergent Validity and Construct Reliability Test Results

Constructs/Variables		Indicator	Outer Loadings	AVE	CR	Conclusion
Asset (X1)	Optimization	X1.1; X1.2	0,824; 0,795	0,655	0,791	Valid & Reliable
Customer Loyalty (Y1)		Y1.1; Y1.2; Y1.3	0,782; 0,812; 0,845	0,661	0,854	Valid & Reliable
Dynamic Capabilities (Y2)		Y2.1; Y2.2; Y2.3	0,761; 0,850; 0,803	0,649	0,847	Valid & Reliable
Company Performance (Y3)		Y3.1 (Financial Ratio); Y3.2 (Springate)	0,882; 0,841	0,743	0,852	Valid & Reliable

Source: SmartPLS Analysis Results (panel data of 108 observations).

Table 3 shows that the reported outer loadings exceed 0.70, AVE exceeds 0.50, and CR exceeds 0.70, supporting convergent validity and internal consistency under the study's reflective measurement specification. This specification represents an empirical simplification: several administrative indicators are heterogeneous and may also be defensibly modeled as composites. In particular, the two-indicator asset optimization construct does not cover infrastructure age, maintenance investment, or capacity utilization; therefore, content validity should be interpreted cautiously.

Table 4

Heterotrait-Monotrait Ratio (HTMT) Matrix for Discriminant Validity

Construct	X1	Y1	Y2	Y3
Asset Optimization (X1)	—			
Customer Loyalty (Y1)	0,685	—		
Dynamic Capabilities (Y2)	0,592	0,710	—	
Company Performance (Y3)	0,624	0,755	0,781	—

Source: SmartPLS Analysis Results (panel data of 108 observations).

All HTMT ratio values are below the conservative threshold of 0.85, indicating that the criterion for discriminant validity between the constructs is satisfied.

Common Method Variance (CMV) Testing

The assessment of discriminant validity using the HTMT ratio (≤ 0.85) in Table 4 and the structural collinearity check ($VIF < 5.0$) in the inner model indicated that the constructs were not affected by problematic inter-construct collinearity. However, these tests did not specifically address the potential for common method variance (CMV)—that is, variance attributable to the measurement method rather than to the underlying constructs, which can potentially arise when all constructs are measured using uniform administrative instruments and data sources. As a complementary approach recommended by Podsakoff et al. (2003), this study therefore conducted two additional CMV diagnostics separate from the structural VIF and HTMT assessments, namely Harman's single-factor test and a full-collinearity VIF assessment.

First, Harman's single-factor test using nonrotated factor extraction showed that no single factor accounted for more than 50% of the total variance; the dominant factor accounted for only 38.42% of the variance. This result suggests that no dominant single-factor pattern was evident

in the measurement instrument. Second, following the full-collinearity assessment procedure developed by Kock (2015), each latent construct was alternately treated as an endogenous construct with all other constructs in the model as predictors. The results showed construct-level VIF values ranging from 1.48 to 2.24, well below the conservative threshold of 3.3 recommended by (Kock, 2015). Taken together, these diagnostics suggest that a dominant single-method factor was not evident under the procedures applied. However, these tests do not address intra-branch dependence, temporal dependence, year effects, or causal identification, which remain separate methodological limitations.

Evaluation of Structural Model (Inner Model) — Case of PDAM Jember

After establishing the validity and reliability of the measurement model, structural model testing was conducted. The collinearity assessment showed that all VIF values were below 3.0, which is also below the 5.0 threshold, indicating that the model was not affected by problematic multicollinearity. The predictive quality of the model was evaluated using R^2 , Q^2 , and f^2 , as presented in Table 5, while the direct path coefficients are presented in Table 6.

Table 5

Coefficient of Determination (R^2), Predictive Relevance (Q^2), and Effect Size (f^2)

Endogenous constructs	R^2	R^2 Adj.	Q^2	Interpretation
Customer Loyalty (Y1)	0,375	0,369	0,281	Moderate; Predictive Relevance
Dynamic Capabilities (Y2)	0,297	0,290	0,196	Weak-moderate; Predictive Relevance
Company Performance (Y3)	0,681	0,672	0,498	Substantial; High predictive relevance

Source: SmartPLS Data Processing Results. Inter-path f^2 values: $X1 \rightarrow Y1$ (0.60); $X1 \rightarrow Y2$ (0.42); $X1 \rightarrow Y3$ (0.19); $Y1 \rightarrow Y3$ (0.28); $Y2 \rightarrow Y3$ (0.33). Model fit: SRMR = 0.068 (< 0.08); NFI = 0.861.

The R^2 value of 0.681 for company performance shows that the model explains 68.1% of the variance in performance, which falls within the substantial category according to (Hair et al., 2021). All Q^2 values above zero indicate predictive relevance, and an SRMR of 0.068 meets the stated model-fit criterion. The f^2 effect sizes indicate that the asset optimization paths to customer loyalty ($f^2 = 0.60$) and dynamic capabilities ($f^2 = 0.42$) are relatively large, whereas the direct effect of asset optimization on performance is relatively moderate ($f^2 = 0.19$), providing an initial indication of a mediating role.

Table 6

Direct Structural Line Coefficient SEM-PLS — Case of PDAM Jember Regency (2011–2019)

Inter-Variable Relationships	Line Coefficient (β)	t-Statistics	p-Values	Remarks
H1: $X1 \rightarrow Y1$ (Customer Loyalty)	0,612	6,845	< 0.001	Supported
H2: $X1 \rightarrow Y3$ (Enterprise Performance)	0,398	4,127	< 0.001	Supported
H3: $X1 \rightarrow Y2$ (Dynamic Capability)	0,545	5,316	< 0.001	Supported
H4: $Y1 \rightarrow Y3$ (Company Performance)	0,487	5,792	< 0.001	Supported
H5: $Y2 \rightarrow Y3$ (Company Performance)	0,521	6,203	< 0.001	Supported

Source: SmartPLS Data Processing Results ($N = 108$). Significance criteria: $t > 1.96$ and $p < 0.05$.

All direct-effect hypotheses (H1–H5) were positive and statistically significant. The most prominent finding was the dynamic capabilities–enterprise performance pathway (H5, $\beta = 0.521$), which had the largest direct effect, exceeding the effect of customer loyalty ($\beta = 0.487$) and the direct effect of physical asset optimization ($\beta = 0.398$). This finding indicates that the dynamic capabilities of human resources may play a key role in converting the physical assets of BUMD entities into sustained operational and financial performance.

Mediation Test Dynamic Capabilities and Customer Loyalty

To answer RQ2 and test H6–H7, a specific indirect-effect analysis was performed using bootstrapping with 5,000 subsamples. The results are presented in Table 7.

Table 7

Specific Indirect Effect Test Results

Mediation Pathway	Indirect Effects	t-stat	p-Value	95% CI (BC)	VAF
H6: X1 → Y2 → Y3	0.284	3.981	< 0.001	[0.152; 0.417]	29.0%
H7: X1 → Y1 → Y3	0.298	4.207	< 0.001	[0.164; 0.433]	30.4%

Source: SmartPLS Data Processing Results (N = 108). BC = Bias-Corrected. The total effect of X1 → Y3 = 0.398 (direct) + 0.582 (total indirect) = 0.980.

Note: The combined indirect effect is 0.582, calculated as 0.284 + 0.298. With a direct effect of 0.398, the total effect is 0.980, resulting in a combined VAF of 59.4%. Both pathways therefore indicate complementary partial mediation.

Both specific indirect effects were statistically significant because their 95% confidence intervals excluded zero. In the parallel mediation model, the total indirect effect was 0.582, obtained from the dynamic capabilities pathway (0.284) and the administrative customer loyalty pathway (0.298). With a direct effect of 0.398, the resulting total effect was 0.980. The pathway-specific proportions were 29.0% for dynamic capabilities and 30.4% for administrative customer loyalty, while the combined VAF was 59.4%. These results indicate complementary partial mediation. Nevertheless, the near-unit total effect and the repeated branch-year structure require cautious interpretation.

The reporting of bias-corrected confidence intervals based on 5,000 bootstrap subsamples for both indirect effects in Table 7—H6 [0.152; 0.417] and H7 [0.164; 0.433], neither of which contained zero—was consistent with contemporary PLS-SEM reporting practices Hair et al. (2021) and strengthened the inference regarding the presence of indirect effects. Furthermore, to determine whether dynamic capabilities (Y2) were associated with performance only through customer loyalty (Y1), the structural results show that both mediators had significant direct pathways to company performance (Y3): customer loyalty (H4: Y1 → Y3; $\beta = 0.487$; $p < 0.001$) and dynamic capabilities (H5: Y2 → Y3; $\beta = 0.521$; $p < 0.001$). Thus, Y2 is not associated with performance solely through Y1 but also has an independent direct association with performance that is even greater in magnitude. A complete inter-construct correlation matrix, with the square root of AVE on the diagonal as the Fornell-Larcker (1981) criterion, is presented in Appendix C for additional transparency.

Longitudinal Analysis of the Perumda Tirta Moedal Case in Semarang City (2017–2024)

To examine whether the Semarang case exhibited a pattern consistent with the exploratory structural findings from Jember, the post-restructuring financial and operational trends of Perumda Tirta Moedal for 2017–2024 were analyzed descriptively, as presented in Table 8.

Table 8

Financial and Operational Performance Trends of Perumda Tirta Moedal Drinking Water Semarang City (2017–2024)

Indicator	2017	2018	2019	2020	2021	2022	2023	2024
Status (PUPR)	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy
Status (Ministry of Home Affairs 47/99)	Good	Good	Good	Good	Good	Good	Good	Good
ROE (%)	4,2	5,1	5,8	4,9	6,3	7,4	8,1	8,6
Operating Ratio (%)	88	85	83	86	82	80	78	76
Cash Ratio (%)	145	160	178	205	240	310	350	380
Billing Effectiveness	95,2	95,6	96,1	95,4	96,3	96,8	97,1	97,4

(%)								
Production Efficiency (%)	80	81	82	79	81	83	84	85
NRW (%)	32	30	29	38	34	31	29	28
Service Coverage (%)	92	91	90	89	88	87	86	85
Springate Score	S- 0,98	1,05	1,12	0,89	1,24	1,31	1,19	1,15

Source: Report on the Results of the Performance Evaluation of BPKP Representative of Central Java Province (2018–2025). The slanted figure (Springate 2017–2020) is an estimated integrated mathematical calculation based on the trend of the post-debt-to-equity swap balance sheet to complement the longitudinal analysis; The 2021–2024 figures are sourced from real audit data.

Table 8 shows that Perumda Tirta Moedal maintained Healthy (PUPR) and Good (Kepmendagri) ratings during the observed post-conversion period. Importantly, the Springate values for 2017–2020 are researcher estimates reconstructed from post-conversion balance-sheet trends rather than audited Springate figures; only the 2021–2024 values are derived from available audited data. These estimated values are used descriptively and should not be treated as equivalent to audited observations.

Discussion

The Impact of the Debt-to-Equity Swap Policy (2016) on Financial Performance

The 2016 debt-to-equity swap policy, valued at Rp656.4 billion, immediately eliminated the burden of historical external debt that had weighed on the company's solvency structure for decades. This long-term debt write-off reduced the Debt-to-Equity ratio to a very low range (<2.1% since 2017), freeing cash from annual interest obligations that had previously absorbed operational liquidity.

The direct impact of reduced interest expense can be seen in the stable growth of net profitability, with ROE gradually increasing from 4.2% (2017) to 8.6% (2024). PAD's ability to generate contributions through dividends increased significantly, from IDR 4.8 billion (2017) to IDR 15.6 billion (2024). Cumulative taxes and dividends paid to the regional treasury reached IDR 98.7 billion through the end of 2024. This finding indicates that institutional investors can strengthen the relationship between ESG and firm value.

Bankruptcy Analysis Using the Springate Model

The reported Springate scores remained above the non-distress threshold of 0.862 throughout the 2017–2024 series. However, the values for 2017–2020 were researcher estimates, whereas the 2021–2024 values were based on available audited data. The series therefore indicates a non-distress pattern within the Springate framework but does not independently establish long-term financial security or demonstrate that the debt conversion caused the observed condition.

However, closer examination shows that the Springate score experienced a moderate downward trend after peaking in 2022 ($S = 1.31$), declining to 1.15 in 2024. Mathematically, this may be associated with the influx of Government Capital Participation (PMP) funds, which increased the asset base and affected ratio A (Working Capital/Total Assets) and ratio D (Sales/Total Assets). On the other hand, a relatively large idle cash balance, averaging IDR 187 billion throughout 2021–2024, represented funds allocated to the West Semarang SPAM project, which experienced delays in fund absorption because of adjustments to the operational cooperation scheme. This accumulation of current assets that had not been fully utilized diluted asset-utilization efficiency, as reflected in the slight decline in the Springate score, even though the company's absolute profitability continued to increase.

Technical Challenges of Asset Optimization: The Classic Problem of Water Loss (NRW)

Although financial solvency has recovered, physical inefficiencies continue to constrain the optimization of Perumda Tirta Moedal's assets. The NRW rate remained high, ranging from 28% to 38% (average 31.3%), broadly consistent with the average NRW rate of PDAM Jember

Regency of 33.5%. This figure substantially exceeds the national tolerance threshold of a maximum of 20% cited by the Ministry of PUPR.

Based on the structural testing of Case 1, the direct effect of asset optimization on performance was the weakest among the direct asset-to-outcome pathways ($\beta = 0.398$), whereas the indirect effect through dynamic capabilities was substantial ($\beta = 0.284$; Table 7). This finding indicates that substantial investment in physical production assets, such as the construction of new transmission pipelines, may not directly translate into improved profitability if dynamic capabilities for mitigating technical leakage in downstream distribution networks are overlooked. Technical analysis in the Semarang case showed that asbestos-cement and cast-iron pipes more than 25 years old accounted for 65% of total physical water loss.

These findings indicate that persistent NRW is an operational constraint that remains after balance-sheet recovery. Technology choices are therefore treated as practical implications rather than as evidence generated directly by this study; any future investment in leak detection or metering should be preceded by a documented technical-economic appraisal and pilot evaluation.

Customer Loyalty and Financial Reliability: Testing the Cost Mechanism

Perumda Tirta Moedal maintained billing effectiveness above 95%, reaching 97.4% in 2024. This pattern indicates consistently high administrative payment compliance. It is compatible with the cost mechanism proposed by Bhattacharya et al. (2021), but the present study did not directly measure customer attitudes, collection costs, or reductions in doubtful-account provisions. Accordingly, billing effectiveness should not be interpreted as conclusive evidence of attitudinal customer loyalty.

The cash ratio increased from 145% in 2017 to 380% in 2024, while billing effectiveness remained above 95%. During the same period, reported service coverage declined from 92% to 85%. Because the data used in this study do not isolate the effects of population-base revisions, changes in service areas, or actual customer growth, the cause of the declining service coverage cannot be determined conclusively from the available evidence.

The Role of Dynamic Capability Mediation Based on Knowledge Management

The H6 indirect coefficient ($\beta = 0.284$) and H5 direct association ($\beta = 0.521$) indicate that the study's human-capital proxies for dynamic capabilities are associated with performance. In Semarang, the independently engineered presedimentation system at the Kudu Water Treatment Plant in 2023 provides an illustrative example of technical adaptation. Because this is a single documented innovation, it is not treated as comprehensive evidence that dynamic capabilities operate systematically across all units or functions.

By utilizing a natural retention pond as an additional physical presedimentation tank and modifying the raw-water overflow gutter, the engineering team succeeded in reducing the turbidity of raw water before it entered the main treatment process. This innovation reduced the consumption of chemical coagulants from an average of 42 ppm to 27 ppm, saving IDR 1.2 billion in chemical procurement costs per budget year. The success of this innovation is supported by increased participation in certified competency training (functional training participation ratio of 78% by 2024), which is theoretically consistent with the proposition of Zack et al. (2009) that structured and institutionalized knowledge management can contribute to sustainable cost efficiency.

Cross-Case and Cross-Theory Synthesis: Two Tracks, One Mechanism

Cross-case comparison yields a corroborative, rather than equivalent, pattern for RQ3. Jember provides exploratory statistical evidence of structural associations and partial mediation, whereas Semarang provides descriptive post-restructuring trends and one illustrative operational innovation. The Semarang evidence is therefore consistent with the proposed capability mechanism but does not independently test or validate that mechanism. This asymmetry limits the strength of cross-case inference.

In the Jember case, the optimization of physical assets must be accompanied by adequate staffing and engineering competence to support consistent efforts to reduce NRW. In the Semarang case, the balance-sheet restructuring involving Rp656.4 billion in debt conversion

created fiscal space on paper; the actual conversion of this fiscal space into profitability (ROE) and operational cost efficiency (Operating Ratio) required organizational adaptation over time, during which management developed technical innovations (such as the Kudu Water Treatment Plant (IPA Kudu) innovation) and managed working capital more effectively. Without the dynamic capabilities of qualified human resources, even capital injections and substantial financial restructuring may fail to suppress physical and technical inefficiencies such as NRW, which remained high in both cases.

These findings extend the contribution of integrating Resource-Based Theory and Dynamic Capabilities theory to public sector organizations with state ownership. In contrast to the mainstream strategic management literature, which bases the need for dynamic capabilities on the dynamics of open-market competition, this study indicates that, even in a natural-monopoly industry that is relatively insulated from competitive pressures, organizations are still required to develop dynamic capabilities to navigate the duality of their mandate (social-commercial) and the volatility of government regulatory policies.

The Semarang case was not modeled using PLS-SEM and therefore cannot validate the mediation coefficient obtained from the Jember case. Its post-restructuring trends and the documented Kudu innovation provide only descriptive corroboration of the proposition that organizational capabilities may influence how financial and physical resources are utilized. Consequently, the cross-case findings should be interpreted as theoretically consistent but evidentially asymmetric.

Practical Implications

Based on the synthesis of the analysis, three practical recommendations were formulated:

1. Assessing network digitalization options. Perumda Tirta Moedal may assess the feasibility of pressure monitoring, leak detection, and smart-metering technologies as part of its NRW-reduction strategy. Any use of available funds should be based on technical-economic feasibility, regulatory authorization, procurement requirements, and pilot results. The present study does not establish the appropriate investment amount or expected financial return.
2. Standardized KPIs for knowledge management. The Capital Owner's Power of Attorney (KPM) in the regions is recommended to include the risk-management maturity ratio and the achievement of certified applied-technology innovations as formal Key Performance Indicators (KPIs) for the BUMD Board of Directors, rather than treating them merely as administrative complements.
3. Standardization of open knowledge documentation. The Kudu IPA chemical-saving innovation should be formalized into standard operating procedures (SOPs) and documented in a corporate knowledge-management system so that it can be replicated in other production units and the loss of technical expertise caused by the retirement of key staff can be minimized.

CONCLUSION

For RQ1, the Jember model shows positive structural associations between asset optimization, administrative customer loyalty, and performance. For RQ2, dynamic capabilities, measured narrowly through employee and training proxies, partially mediate the asset optimization–performance association, while administrative customer loyalty provides a second partial pathway. For RQ3, the Semarang post-restructuring series offers a corroborative pattern: solvency and billing performance improved while NRW remained high, suggesting that financial relief alone is insufficient.

This is not evidence that the debt conversion caused the observed changes or that both cases share a statistically identical mechanism. The conclusions are limited by nonoverlapping observation periods, potential regulatory, macroeconomic, and pandemic confounding, estimated Springate values for Semarang in 2017–2020, repeated branch-year observations without cluster- or panel-aware inference, narrow proxy measurement of dynamic capabilities and asset optimization, asymmetric evidence across cases, and the purposive selection of only two utilities. Future research should use pre/post baselines and comparison utilities, panel or multilevel models with clustered inference, richer measures of sensing, seizing, and transforming

capabilities, direct attitudinal and administrative customer measures, and additional BUMD entities. Practically, utilities should link post-restructuring fiscal space to audited asset-maintenance priorities, workforce capability development, and monitored NRW-reduction programs.

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AUTHOR CONTRIBUTION STATEMENT

Ady Setiawan was responsible for conceptualization, methodology, data collection, formal analysis, interpretation, manuscript drafting, critical revision, editing, and approval of the final version, and accepts responsibility for the integrity of the work.

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