Enterprise Development & Microfinance, 35:1, 439-456

Institutional Capacity and Operational Constraints in Power Distribution Utilities: Evidence from a Himalayan State Utility

RUPESH THAKUR, DR. NIKITA JAIN

Abstract: *Purpose: This paper examines the impact of institutional capacity and operational constraints, in particular the geographical ones, on the process of implementing power sector reforms. It aims to address the "gap in implementation" of state owned utilities (SUVs) despite much of the policy effort at the national level like UDAY and RDSS.*

Design/Methodology/Approach: Qualitative-dominant Mixed method approach was used in the study with focus on the case study of Himachal Pradesh State Electricity Board Limited (HPSEBL). The data was collected using 84 semi-structured interviews with people at different hierarchical levels (managerial, technical, and field) and also through administrative reports and operational performance data from 2018 to 2023.

Findings: The study identifies a vicious cycle wherein chronic staffing shortages and skill–technology mismatches are exacerbated by difficult terrain. Such factors give rise to institutional absorption bottlenecks that block the way for reforms to flow from the top to the field-level.

Originality/value: The paper generates a Context-Adjusted Resource-Based View (CA-RBV) that puts geographical context in the first order of the resource–performance relationship, and proposes the Institutional–Operational Nexus (ION) framework as a diagnostic tool for utility underperformance in geographically constrained environments. Contributions to the present study question the linearity of the standard reform templates and build a spatially sensitive theory of public utility performance, with 84 field level interviews.

Research limitations/implications: This study is conducted in one utility in the Himalayan state, but CA-RBV can be applicable in other utility areas in remote or developing areas worldwide. Future studies need to expand the model to comparative analyses between multiple states.

Practical implications: Terrain adjusted benchmarks should be included in reform policy and regulation. The training infrastructure and capacity building for utilities should be decentralised and an emphasis placed on local rather than top-down technology mandates.

Social implications: Far away hill-state communities that are relying on hill-state utilities are affected disproportionately by failures in reform

Rupesh Thakur (thakurrupesh91@gmail.com) Research Scholar , Department of Commerce
Banasthali Vidyapith, Rajasthan, India
Dr. Nikita Jain (nikitajain@banasthali.in) Assistant Professor , Department of Commerce , Banasthali Vidyapith, Rajasthan, India
Corresponding author: Rupesh Thakur

implementation. For reliable access to electricity and to bridge the service quality gap of Himalayan and other marginalised communities, the design of policy needs to be terrain sensitive and equitable regulatory benchmarking is required.

Keywords: Power distribution; institutional capacity; utility management; Himalayan region; energy sector reforms; HPSEBL; Resource-Based View; implementation gap

Paper type: Research paper (empirical case study)

Introduction

Power distribution utilities (DISCOMs) are under greater strain than ever before as the world moves towards energy transition and universal and reliable access to electricity. Although the generation and transmission networks have seen structural gains in the last 20 years, India's distribution network is the ‘weakest link’ in the power value chain, and has been facing a host of issues like financial losses, aggregate technical and commercial (AT&C) losses, and operational inefficiencies (Jain et al., 2022; Ministry of Power, 2022).

Investing a large amount of capital for modernisation of distribution infrastructure, successive national reform programmes have been undertaken ranging from the Accelerated Power Development and Reform Programme (APDRP) to the Revamped Distribution Sector Scheme (RDSS) and the Ujjwal DISCOM Assurance Yojana (UDAY). However, there is a mixed empirical evidence on the effect of such policies. Typically, performance gains have been concentrated in urban and semi-urban utilities with more favourable institutional settings, while utilities in remote, mountainous, and/or geographically limited utilities have continued to struggle to meet regulatory benchmarks (Planning Commission, 2014; CEA, 2023).

In the current literature on the subject, the problem of distributional failure has been blamed on political interference, lack of adequate regulation or reluctance to adopt technology (Tongia, 2003; Bhatt, 2015). These explanations are valid at the macro level, but can be misleading at the micro level of the foundations of utility performance: the capacity of the organisation to absorb, adapt and execute centrally imposed reforms. This is especially true in a geographically restricted area like the Himalayas, where standard performance metrics AT&C losses, billing efficiency and mean time to repair (MTTR) are often disconnected from the field operations.

The present study attempts to fill this void by studying the case of the state owned electricity board (HPSEBL) which has to operate across the highly diversified terrain of the Himalayas. The paper examines the following question of research, based on 84 semi-structured interviews and secondary performance data, that were triangulated:

> *How do institutional rigidities and geographical constraints mediate the relationship between centralised reform mandates and actual field-level service reliability in a Himalayan state-owned utility?*

The paper unfolds as below. Section II examines the literature related to the power sector reform in India, institutional capacity theory and geographical institutionalism. The CA RBV theoretical framework and the Institutional–Operational Nexus (ION) model is developed in Section III. The research design in this study is mixed-methods which is explained in Section IV. Section V summarizes results from the three domains of structural constraints. Section VI considers the mismatch between the design of reform and what happens in the field; it takes the CA-RBV a step forward analytically. Conclusions about policy and scholarship are offered in Section VII.

Literature Review

2.1 The Trajectory of Indian Power Distribution Reform

Since the Electricity Act 2003, which called for the vertical disintegration of state electricity boards and establishment of independent regulatory commissions (Dubash and Rajan, 2001; Prayas Energy Group, 2023), a series of policy interventions have been introduced in India's power distribution sector. The successive schemes of the Central government – APDRP (2002), R-APDRP (2008), UDAY (2015) and RDSS (2021) have cumulatively transferred hundreds of thousands of crores for modernising the distribution network infrastructure (Ministry of Power, 2022). In spite of this investment, it is consistently pointed out in the scholarly literature that there is a disconnection between financial investments and operational performance, the reasons for this performance being attributed to political economy, regulatory capture, and cross-subsidy distortions (Tongia, 2003; Bhatt, 2015; Chatterjee, 2020).

Increasingly, however, empirical studies have pointed to the fact that the political economy explanation is necessary but not sufficient to explain all the variations in the performance of DISCOMs (Jain et al., 2022). What Bhattacharyya (2013) has shown is that the results of energy sector reform in a developing economy is dependent on the absorptive capacity of the organisations that are required to implement change — or, their capacity to internalize, adapt and operate externally mandated changes. The NITI Aayog (2021) has done a more recent analysis which shows that the workforce composition and training gaps are first order constraints in the rollout of smart grid in geographically distributed service territories. However, no systematic attempts have been made to theorise the interaction between geographical context and institutional capacity that leads to observed variations in performance between utilities.

This is born out of comparative evidence from international utility reform programmes which also shows that context-sensitive analysis is important. Cross-national studies on electricity sector liberalisation have consistently shown that the performance gains depend on the existing institutional endowments of the entities implementing liberalisation, such as the quality of managers, management systems and organisational absorptive capacity and not, only, on the technical design of the liberalisation instrument(s) (Bhattacharyya, 2013). This trend is seen in the Indian context in the opposite directions of state-owned utilities that have been given similar amounts of central funding with differing results on operation. Great utilities like Gujarat's DISCOMs can be characterized by institutional depth and continuity of management and not just by the magnitude of capital investment (Jain et al., 2022). The implication for reform design is clear: financial and technological interventions should be preceded by (or co-designed with) an assessment of the institutional absorptive capacity of target organisations; an approach which has not been included in current national programmes for reform.

2.2 Institutional Capacity and Reform Implementation in Public Utilities

The idea of institutional capacity has become a key one in the public management and development administration literature (Grindle, 1996; Andrews et al., 2012). Andrews et al., (2012) argue that in the delivery of public services, institutional capacity refers to all the human, organizational and technical resources that make it possible for an organization to deliver the services required by its mandate in a consistent manner. In developing countries, institutional capacity limitations, and not just financial or political limitations, were the main reason for low achievements of State-sponsored reform programmes, as revealed in Grindle's (1996) seminal work. Later research work has extended this understanding to infrastructure industries: North's (1990) institutional economics gives a theoretical explanation of how the formal rules, informal constraints and enforcement mechanisms influence the performance of organisations, while Wernerfelt's (1984) and Barney's (1991) work is rooted in firm level resource endowments.

Absorptive capacity, first introduced by Cohen and Levinthal (1990) and then further developed by Zahra and George (2002) offers a micro-level mechanism which links institutional resources and reform uptake. Absorptive capacity – which has been defined as an organisation's capacity to acquire, assimilate, transform, and exploit new knowledge – has been widely used in technology management and innovation studies (Teece et al., 1997) but has not been sufficiently used as an analytical construct in utility management studies. The present study takes this idea and expands it to the case of power distribution, where absorptive capacity is not the same for all utilities, but rather is systematically affected by geographical operating conditions.

Building on the absorptive capacity theory, Szulanski (1996) proposes that there are three aspects of knowledge stickiness (i.e. the resistance to knowledge transfer), namely the complexity of knowledge transferred, the difficulty of articulating the knowledge and the difficulty of transferring the knowledge even in a willing recipient organisations. In distribution utilities, knowledge stickiness translates to the ever-present disconnect between the operational excellence that is captured in centrally developed reform programmes, and the skills possessed by the people on the ground. This 'stickiness' increases when the receiving unit does not have the educational background and the formal training system to translate the externally provided knowledge into something that is worked reliably. Systematic review of the public management literature by Andrews et al. (2012) shows that human capital depth is the most consistent predictor of public service performance improvement; however, this is among the least targeted resources in typical reform programmes which focus on the deployment of ‘hardware’ rather than on development of the workforce. Geographically spread out utilities in mountainous areas, where participation in centralised training facilities are structurally limited, this is not only a policy decision, but a spatial fact, unless specifically targeted through decentralised capacity-building approaches.

2.3 Geographical Context and Organisational Performance: The Gap in the Literature

Geographical institutionalism (Rodríguez-Pose, 2013) suggests that institutional and material organisations in a specific place influence their ability to act, innovate, and comply with external requirements. This has been used in the study of regional economic development and location decisions of firms, although not so much in the management of public utilities. Geography, as a determinant of utility management, is typically regarded as a control variable or background condition in the existing literature on utility management (Jain et al., 2022). This omission has implications in the India-specific context of hill-state electricity utilities: the unique operating conditions of these utilities, in terms of altitude, fragmentation of settlements/landscape, seasonal access, and dispersed settlement patterns are qualitatively different from that assumed by the national policy frameworks. This paper does just that, offering a theoretically grounded perspective based on empirical analysis that places geographical context at the center of the analysis.

The importance of geography for the performance of utilities is further highlighted by the increasing evidence from utilities in similar hill regions in India. The Uttarakhand Power Corporation Limited (UPCL) notes that despite the similar geography to HPSEBL's, there are consistent vacancy rates in technical posts, limited training facilities in remote divisional circles and MTTR performance in high altitude zones that consistently falls short of the national standards by similar margins (CEA, 2023; Planning Commission, 2014). There are other instances, such as in Meghalaya and Sikkim, where the low population density, seasonal restrictions on access and a lack of local skills development facilities complicate the issue of electricity service delivery. The findings of this study indicate dynamics that are common to a wider and more theoretically defined class of mountain-state distribution utilities that has not been sufficiently distinguished from its plains-state counterparts, and which thus lacks the theoretically and policy-specific toolkit it needs to understand its unique challenges.

Theoretical Framework: The Institutional–Operational Nexus

3.1 The Resource-Based View in Public Utility Settings

According to Resource-Based View (RBV) of the firm, the firm can gain sustainable competitive advantage if it owns valuable, rare, inimitable and non-substitutable internal resources and capabilities (Barney, 1991). Although it was first conceived in the commercial world, RBV is now being used in the public sector with success as an explanatory tool for varying performance (Grindle, 1996; Andrews et al., 2012). The corresponding one in public utilities is institutional capacity, which refers to the sum of people, procedures, stock of knowledge and adaptive mechanisms that shape how an organisation operates in fulfilling its mandate.

However, the standard RBV model assumes that resource deployment takes place in relatively uniform operational environments. For utilities in geographically constrained territories, this assumption fails. We therefore propose an extension—the Context-Adjusted Resource-Based View (CA-RBV)—which incorporates geographical context as a structural moderator of the resource–performance relationship.

3.2 The Institutional–Operational Nexus (ION) Framework

Building on the CA-RBV, this study proposes the Institutional–Operational Nexus (ION) framework (Figure 1). The ION framework posits two interacting dimensions:

Institutional Capacity —comprising human capital, training infrastructure, internal coordination mechanisms, and knowledge management systems—determines the utility's capacity to absorb new reform mandates. In this context, absorption capacity refers to the organisation's ability to acquire, assimilate, transform, and exploit new technical knowledge and procedural requirements (Cohen and Levinthal, 1990).

Operational Constraints —comprising terrain complexity, asset dispersion, weather extremes, and logistical difficulty—act as structural moderators that determine the effective effort-to-outcome ratio. In constrained environments, the same reform initiative requires disproportionately more institutional resources to achieve equivalent outcomes than in low-constraint settings.

These two dimensions combined deliver what the present study calls institutional absorption bottlenecks: structural conditions where the utility's institutional resources are insufficient to cover the costs to implement the required reform, resulting in a vicious cycle of deferred maintenance, underutilised technologies and deteriorating operations. This cycle is represented in Figure 1, which illustrates the reinforcing relationships that exist between workforce, skill fragmentation, terrain and the uptake of reform.

The ION framework enriches the existing literature in the field of utility management (Bhatt, 2015; Jain et al., 2022) by including the geographical context as a first order analytical variable, instead of background. This is in line with the recent geographical institutionalist literature (Rodríguez-Pose, 2013), which suggests that the capacity of organisations is shaped by material conditions particular to the place where they are situated, and which are often impossible to cater for with policies with spatial uniformity.

Research Methodology

4.1 Research Design and Philosophical Positioning

A case study design that focused on qualitative information was followed. Case study methodology is a suitable approach to answer a ‘how' and ‘why' question in a context-dependent organisation (Yin, 2018). HPSEBL was chosen as the case organisation as a result of fulfilling the criteria for purposive sampling as mentioned by Patton (2002) that is, a large state-owned utility, with diverse topography (from plains down to river valleys and high-altitude areas above 4000m), facing the entire gamut of national reform requirements and the organisation is a theoretically revelatory case as per Yin (2018). The study has a critical realist ontological stance (Bhaskar, 1978), in which the constraints of the institutions and the outcomes of their operations are seen as real phenomena, which can be known through systematic empirical enquiry and the accounts of the respondents are considered to be mediated by their organisational position and subjective experience. The lead researcher's access to field operations in HPSEBL enabled an in-depth data collection, while at the same time being recognized as a potential source of insider bias which was mitigated by the systematic coding, external peer-debriefing and the audit trail requirements of the Framework Approach (Miles et al., 2014).

4.2 Data Collection

84 semi-structured interviews were held to gather primary data from January to December 2024. The respondents were selected from each of the operational circles of HPSEBL and the sampling was done according to hierarchical level as 12Strategic level officers (Superintending Engineers/Chief Engineers), 28 Operational level (Assistant Engineers/Executive Engineers) and 44 Field level (Junior Engineers and Linemen). This stratification allowed the study to get into policy formulation perspectives and realities at the field level (see Table II).

Interview guides were tailored by hierarchical level but anchored to a common set of thematic domains: workforce adequacy, technical skill and training, terrain and logistics, reform implementation experience, and inter-departmental coordination. Interviews were audio-recorded with informed consent, transcribed verbatim, and, where necessary, translated from Hindi or the local dialect.

Secondary data—including HPSEBL Annual Administrative Reports (2018–2023), CEA Performance Reviews, and RDSS scheme documents—were used to triangulate and contextualise the qualitative findings.

4.3 Analytical Approach and Quality Assurance

Qualitative data have been analysed using the matrix-based Framework Approach (Ritchie and Spencer, 1994), which is appropriate for policy-relevant research where it is important to make systematic comparisons between the different groups of respondents. The analytical steps taken were: (1) repeated reading of data and initial memo-writing to familiarize oneself with the data; (2) Identification of a thematic framework that was both inductively derived from the data and deductively derived from the ION framework; (3) Indexing and charting of data across the matrix; and (4) interpretation and theory-building. To ensure for analytical rigour, inter-coder reliability was conducted on 20% random subsample of transcripts by another independent researcher and an inter-coder reliability of 0.81 (Cohen's kappa coefficient) was obtained which shows good level of agreement (Landis and Koch, 1977). Guest et al., (2006) suggested that the sample size was adequate, with no new substantive codes identified during the last 14 of the 84 interviews, which determined the theoretical saturation. Descriptive analysis of quantitative secondary data obtained from HPSEBL Annual Reports, and CEA Performance Reviews was conducted and the findings were complemented by the findings of the interview for convergent triangulation (Miles et al., 2014). Further to increase the trustworthiness, member checking was conducted with five respondents and peer de-briefing was done with two independent academic reviewers.

The study was approved by the appropriate institutional review board for ethical reasons. The confidentiality of all participants was ensured and identifying information has been de-identified from all the quotations presented below.

Findings and Analysis

5.1 The Staffing–Efficiency Paradox

A common and growing theme among all groups of respondents was the critical and increasing disconnect between “authorized” and “real” workforce sizes. Table I shows that, in technical cadres, the vacancy rate is between 35% and 40%, the deficit being at the field level – where the implementation of the reform mandates takes place on the ground.

The impact on operations of this shortfall is a profound change with the utility's maintenance mode. The majority of the respondents (83%, or 84 out of 100) have indicated HPSEBL's field teams have been unable to maintain proactive preventive maintenance schedules because of a switch to reactive breakdown repair. One of the field level engineers expressed this as follows:

> *"We do not have the workforce to patrol lines regularly. We wait for a fault, then we go. By the time we reach some of the high-altitude feeders, a day has already been lost."*

The implications for the implementation of reforms are straight-forward. RDSS needs a constant presence in the field for the installation, calibration and consumer interface of smart-metering. If there is one lineman per 20 kilometres of distribution line, this is not structurally available for a significant part of the distribution line network.

A comparative perspective of HPSEBL's operational indicators when compared to the national indicators is given in Table III. The loss numbers of the utility, on a relative basis (12% - 14%), are also low when compared with a number of other state corporations in the country, but this mask the inherent fragility of the current operating structure—the cost of reducing loss is much higher in the context of the Himalayas as compared with the assumptions implicit in the national benchmark.

Table I: Institutional Constraints and Reform Outcomes in HPSEBL

Constraint	Operational Manifestation	Impact on National Reform (UDAY/RDSS)
Workforce Scarcity	1 Lineman per 20 km of line; ~35–40% vacancy in technical cadres	Delayed implementation of smart-metering and billing upgrades
Skill Mismatch	Reliance on experiential rather than data-driven decision-making; informal peer learning dominates	Under-utilisation of GIS/SCADA analytics is mandated under RDSS.
Terrain Complexity	Increased transport and logistics costs in high-altitude zones	Inaccurate loss-reduction benchmarking; inequitable regulatory penalties

Source: Compiled by authors from primary interview data (n=84) and HPSEBL Administrative Reports (2021–2023).

5.2 Skill Gaps and Technological Absorption Bottlenecks

The use of SCADA, GIS based asset mapping and smart metering at consumer level are part of the national reform programmes, including RDSS. The present study revealed that the HPSEBL has these technologies in various stages of implementation, but that there is a very low level of utilization, due to what the study calls a knowledge fragmentation effect.

HPSEBL has formal technical training programmes, focused at managerial and mid-level operational levels. Competency is achieved mostly through dissemination of information amongst peers by field staff who are operationally responsible for on-the-ground use of these systems; there is no formal, peer-to-peer knowledge transfer, and hence no form of certification. As was remarked by one of the operational level engineers:

> *The GIS mapping system exists; however, to what extent have our junior engineers been adequately trained in its utilisation? They acquire knowledge from their predecessors. If that individual was incorrect, then the learning process is consequently flawed.*

This knowledge fragmentation creates a structural absorption bottleneck – infrastructure to make the reform-suggested technologies at the field level is underdeveloped. The results range from the individual level of lack of skills to the organisational level of a lack of capacity, and eventually culminate in a delay to a partial implementation of the reform (as portrayed in Table IV).

The percentage of field staff that gets formal technical training in any one year is below 15% (Table III) and the industry best practice is greater than 50%. The geographical limitation magnifies this disparity as there aren't any decentralised training centres in the hilly divisions and hence field staff have to travel long distances to avail formal training, which further limits access to effective training.

5.3 Terrain as a Structural Operational Constraint

HPSEBL's distribution system serves over an area where topography presents qualitatively different operational requirements as compared to a distribution system in a plain or urbanized area. The topographical penalty" arising from the combination of various topographic characteristics – high altitude, narrow access routes in the mountains and seasonal road closures due to snow – and dispersed settlement patterns of Himalayan communities results in a systematic increase in the effort needed to achieve standard operational results.

The topographical penalty can be most easily measured as MTTR differential. Based on primary data and administrative record, the average fault restoration time in high altitude feeders is 6 to 18 hours as compared to less than 2 hours in urban areas as per the standard (Table III). What can be identified and corrected in half an hour in plains based distribution network can be identified and corrected in a day as it takes to reach the remote Himalayan divisions. One of the senior field engineers said:

> *"In winter, the Kinnaur feeders—the road may be closed for three or four days. The supply is gone, and we cannot reach it. The benchmark says two hours. That benchmark was not written with us in mind."*

In high altitude circles like Lahaul and Spiti or Kinnaur, operating expenditure (OPEX) is estimated to be about 2.5 times that in the plains-based industrial circles (e.g. Baddi or Paonta Sahib) in view of higher costs of logistics and equipment transport, and labour requirement for maintenance on difficult terrain. RDSS has no national benchmarking frameworks that include topographical difficulty index. What this means is that hill-based utilities such as HPSEBL are assessed systematically against a standard set to reflect conditions that it is not possible to achieve without undue use of resources due to its geographical location.

Table II: Participant Profile and Key Research Themes

Staff Category	Sample Size (n=84)	Primary Theme Identified	Focus Area
Strategic (SE/CE)	12	Policy Mismatch	Funding allocation and regulatory compliance
Operational (AE/EE)	28	Coordination Gaps	Inter-departmental bottlenecks and procurement delays
Field Level (JE/Linemen)	44	Physical & Skill Constraints	Terrain hazards and acute workforce shortage

Source: Primary field study (2024).

Table III: Comparative Operational Metrics and Institutional Gaps — HPSEBL vs. National Benchmarks

Metric	HPSEBL Performance (Approx.)	National/Urban Benchmark	Institutional Source of Gap
AT&C Loss (%)	12%–14% (variable by circle)	<10% (Smart City target)	High auxiliary consumption and dispersed billing points in remote zones
Billing Efficiency	88%–92%	>95%	Staffing shortage leads to delayed manual meter reading in remote areas
Staffing Gap	~35%–40% vacancy in technical cadres	<10% vacancy (national average)	Recruitment freezes and prolonged administrative approval cycles

Metric	HPSEBL Performance (Approx.)	National/Urban Benchmark	Institutional Source of Gap
Mean Time to Repair (MTTR)	6–18 hours (high-altitude feeders)	<2 hours (urban standard)	Terrain constraints combined with one technician covering multiple remote feeders
Training Frequency	<15% of field staff are trained annually	>50% (industry best practice)	Absence of a decentralised training infrastructure in hilly divisions

Source: Compiled by authors from HPSEBL Annual Administrative Reports (2021–2023) and CEA Performance Reviews (2022–2023).

Discussion: The Contextual Mismatch and the CA-RBV Framework

6.1 The Standard Reform Template and Its Limits

The key implicit assumption in all India's key power distribution reform programmes (UDAY, RDSS, and previous ones) is that technology investments and financial restructuring will yield linear efficiency gains, given the political will and basic institutional building blocks. The validity of this standard reform template has been tested: in the areas where utilities have good institutional conditions (good staffing, working training systems, good terrain, and inter-departmental coordination).

An assumption of linearity is contradicted by the evidence from HPSEBL. In the present study, the effort curve shows a non-linear shape, suggesting that the cost of achieving a certain level of efficiency is significantly greater in more challenging terrain in geographically constrained utilities. HPSEBL's smart-metering investment must be scalable to the number of meters to be replaced, and must be larger by at least 1% compared to the smart-metering investment of a utility with a plains-based network, if the same 1% loss reduction is to be achieved. The reform template which is based on average institutional conditions will therefore systematically underestimate the institutional capacity margin resource requirements of utilities.

There is evidence from similar utilities to support this evaluation. Patterns similar can be seen in Uttarakhand Power Corporation Limited (UPCL), also operating in a similar structural and geographic terrain as HPSEBL, which has also experienced almost similar trend lines of improvement in its AT&C losses in the last ten years under successive national reform plans, and fault restoration times in its high-altitude feeder circles are consistently found to be lagging behind the national benchmarks by margins similar to what has been reported at HPSEBL (CEA, 2023; Planning Commission, 2014). It is important that these results hold across independently managed utilities, with separate management and governance regimes, suggesting that it is a structural factor (terrain/institutional capacity) and not a managerial or governance one. This replication of the structure is exactly what the CA-RBV framework would expect: in the same geographical context the resource-performance relationship should result in similar outcomes, regardless of how the firm is managed. Thus, the HPSEBL case is part of a theoretically coherent, empirically substantiated class of constrained utilities, rather than a case of 'special attention' that could be understood as a result of special management failure.

6.2 The Context-Adjusted Resource-Based View: Analytical Implications

In this paper we have developed an extended version of this standard RBV, the CA-RBV framework, which has three analytically relevant extensions. First, it adopts a geographical context as a first order moderating variable that transforms the resource–performance function that is implicit in standard RBV (Barney, 1991; Wernerfelt, 1984), and even dynamic capabilities theory (Teece et al., 1997). Second, it breaks down institutional capacity into its operational elements – human capital, knowledge assets, organisational structure and geographical context (see Table IV) – making it possible to analyse it in a disaggregated fashion, rather than the "capacity" construct used in previous public management literature (Andrews et al., 2012; Grindle, 1996). Thirdly, it posits the notion of 'absorption capacity', as the mechanism through which institutional capacity determines reform uptake, which only financial and/or political-economy explanations (Tongia, 2003; Bhatt, 2015; Chatterjee, 2020) can only partly provide.

The CA-RBV is most relevant to the literature on utility management within developing economies (Bhatt, 2015; Jain et al., 2022) and to the literature on institutional capacity in public sector reform in general (Grindle, 1996; Andrews et al., 2012). It is not just an Indian phenomenon: utilities in other mountainous or geographically constrained areas (sub-Saharan Africa, Latin America or South-East Asia) have similar structural conditions, and the framework provides a template for a diagnostic.

The CA-RBV also does well with dynamic capabilities theory (Teece et al., 1997) which focuses on the ability of an organization to sense a change in the environment, capture opportunities, and reconfigure its resources to meet the change. In the context of public sector organisations, dynamic capabilities theory can be used to understand the reasons behind the varying levels of adaptability to policy requirements (Andrews et al., 2012). However, in geographically limited settings, the capacity to sense new reform needs and to reconfigure operational resources may be unevenly distributed as a precondition, and may not be available to mountain-state utilities. The CA-RBV therefore adds geographical conditions to the dynamic capabilities theory and identifies when and when not the capability-building mechanisms will work. In HPSEBL it's not about managerial incompetence at the strategic level, it's about the structural inaccessibility of the field level human capital and knowledge infrastructure to translate strategic intent to operational outcomes. This difference (capability at the centre and absorption at the periphery) is important when measuring readiness for reform and the level of support to be provided for reform.

Table IV: The CA-RBV Framework — Institutional Variables and Reform Mediation in HPSEBL

Institutional Variable	Empirical Manifestation (HPSEBL)	Operational Impact	Mediation of Reform (RDSS/UDAY)
Human Capital	83 of 84 respondents cited acute staffing shortages	Shift from preventive to reactive maintenance	Delayed rollout of consumer-side smart metering
Knowledge Assets	Reliance on informal peer-to-peer learning; no structured field-level curriculum	Underutilisation of GIS and SCADA systems	Technology absorption bottleneck at the field level
Organisational Structure	Hierarchical silos between the Technical and Accounts wings	Delayed procurement of critical spares	Inability to meet regulatory Reliability Indices
Geographical Context	Dispersed asset base in high-altitude zones	Increased Mean Time to Repair (MTTR)	Unrealistic loss-reduction benchmarking under national schemes

Source: Developed by authors from primary data (2024); adapted from Jain et al. (2022) and Grindle (1996).

6.3 Policy Implications: Towards Terrain-Sensitive Reform Design

The results have obvious implications for the design of reform programmes and for regulatory practice. Four interventions are suggested:

Topographical Adjustment Indexing: Regulatory benchmarks used within RDSS such as MTTR targets, loss-reduction timelines and smart-metering coverage thresholds should include a ‘Topographical Difficulty Index' (TDI), similar to the remoteness adjustment factors found in the universal service frameworks of telecommunications providers around the world. This is because, without such adjustment, utilities in the most geographically difficult areas are, in essence, penalized for events for which they have no control, resulting in perverse incentives and making true performance improvement difficult to discern. A well-designed TDI for Indian hill-state utilities, based on parameters like altitude, density of road network, and access challenges during the different seasons of the year, would create a fair playing field which would test utilities against conditions representative of their operations.

Decentralised Training Infrastructure: The identified knowledge fragmentation effect is, to a large extent, a structural consequence of the centralisation of technical training infrastructures in urban centres where they are easily accessible. In the remote divisions of the Himalayas, staff are faced with enormous travel distances and time costs to access formal instruction, and hence peer to peer knowledge transfer remains inevitable if there is no formal instruction available. Investment into training centres at division level would directly tackle this institutional challenge, for example, via the RDSS component on capacity building for training, which already provides funding for training, but not decentralised delivery. Especially, skill gaps have been identified in technology areas that are limiting the implementation of reform, such as GIS-based mapping of assets, how to use smart meters, and how to use SCADA systems, which are all areas that need modular, practically oriented curricula.

Institutional Capacity Auditing: Reform readiness assessments are mainly on financial indicators and infrastructure status. An institutional capacity audit would be more indicative of the absorption capacity of individual utilities and assist in calibrating the amount of reform support accordingly, as all utilities must undergo it as a requirement. This audit could be incorporated into the ongoing PFC integrated rating system, providing institutional substance to a rating system which is largely based on financial and operational performance metrics. If the utility's score is below a certain absorption capacity threshold, then targeted capacity building support may be provided before and not necessarily at the same time as technology deployment.

Inter-Departmental Coordination Reform: Table IV indicates that institutional barriers like delays in procurement of critical operation spares directly impacts the responsiveness in the field level due to hierarchical barriers between the Technical and Accounts wing. The standard UDAY and RDSS instruments don't address such a coordination failure since they are aimed at financial restructuring and introducing technology, in this case. An integrated procurement committee with both technical and financial powers with a simplified administrative approval path for time sensitive operational expenditures would directly tackle this bottleneck. Experience of the turnaround of DISCOMs in Haryana, involving detailed and substantive changes in the internal procurement and coordination mechanisms in addition to financial restructuring of the DISCOMs, clearly shows that such organizational design interventions can produce substantial efficiency gains within large state-owned distribution utilities (Prayas Energy Group, 2023).

Conclusion

This study was designed to throw light on the causes of the low level of efficiency gains at HPSEBL, which is a state owned utility in the Indian Himalayan region, from the centralised reform programmes. The research found that the three structural constraints of workforce scarcity, skill–technology mismatch, and topographical challenges are interwoven and form institutional absorption bottlenecks as confirmed by 84 semi-structured interviews and backed by administrative performance data. Rather than being a question of political resistance or technical limitations, these bottlenecks limit the impact of the standard reform template in delivering the desired results at the field level because key institutional conditions for the operationalisation of the reform are missing. Most importantly, this discovery changes the way utilities should think about diagnostics to measure progress toward reform: financial and technical measures are important but not sufficient to gauge a utility's readiness to reform when the capacity to make a change is structurally limited.

The theoretical contribution of this study is twofold: first, the Context-Adjusted Resource-Based View (CA-RBV) and second, the related Institutional–Operational Nexus (ION) framework. These are conceptual tools to offer a structured analytical vocabulary for understanding utility underperformance in geographically bounded spaces, which is under-theorised in mainstream utility management literature. The CA-RBV introduces a novel approach to conceptualizing the implementation gap, one that moves the discussion beyond just financial or political explanations and opens a new path for future comparative research. The ION framework is useful for diagnosis because it breaks down the concept of institutional capacity into such a fine-grained and measurable set of components – human capital, knowledge assets, organisational structure and geographical context – that each can be linked to a specific type of policy intervention. This disaggregation is more than the overall "capacity" concept that has been used in previous public management research (Andrews et al., 2012; Grindle, 1996) and allows the reform designer to recognize the capacities that limit individual utilities, without giving one-size-fits-all prescriptions that may work for well-resourced utilities but fail to help constrained utilities catch up.

The study findings have implications beyond the SDG 7 (Affordable and Clean Energy) agenda and the broader SDGs agenda in general. Putting in the pipes and cables alone does not mean that the potential benefits of universal electricity access will be realised, as the organisations implementing that infrastructure – in this case those serving the most geographically isolated communities – will not have the institutional capacity to maintain, manage and operationalise the infrastructure in a reliable manner over time. Terrain-sensitive reform design is not just a technical choice: it is a condition for just energy access in mountainous and remote areas around the world. The CA-RBV offers an approach by which development agencies, regulators and national governments can consider institutional absorption capacity as a systemic factor, rather than an afterthought once technologies and finance are in place, when considering sustainable energy transition.

Limitations of the study have to be acknowledged. The case study method has the advantage of giving a detailed view of a particular situation, but due to the uniqueness of the topography and institutional context of HPSEBL, the findings of these are not generalizable to other utility settings. To strengthen the empirical underpinning of the CA-RBV, quantitative validation by panel estimation for a number of hill state utilities would be useful to support the non-linear effort curve. Future research should focus on three key research streams: (1) testing the replication of the CA-RBV diagnostic categories in three independent case studies—CA-RBV applied to UPCL, Meghalaya Energy Corporation, and the Sikkim utility—(2) designing and validating a standardized Institutional Absorption Capacity index that can be calibrated for terrain and remoteness, and integrated into national regulatory rating frameworks, and (3) tracking the outcomes of field-level reform in HPSEBL as the RDSS implementation process unfolds, to test whether the capacity-building interventions result in the efficiency gains predicted by the CA-RBV model.

The study calls for a shift in practice for policy and regulatory makers to adopt solutions that are not based on one-size-fits-all reform frameworks, but take into account spatial variations. But in any credible approach to improve the performance of a geographically constrained power distribution utility, institutional capacity (rather than just financial restructuring or technology investments) must be considered as the primary variable. As the analysis at hand shows, institutional capacity (human capital, knowledge management and inter-departmental coordination) is a precondition of, rather than a result of, effective technology absorption and financial restructuring. Capacity-building programmes that take place before the implementation of technical systems instead of simultaneously or following implementation are more likely to result in sustained improvements in geographically localized utilities. Perhaps most actionable takeaway from this study for policymakers working in the energy transition in India and elsewhere to achieve equitable electricity access is this resequencing of reform priorities, from its placement at the periphery to at the front of the implementation logic.

Acknowledgements

The authors would like to thank the officers, engineers and field staff of HPSEBL who took part in this study, and who generously gave their time and professional insights. The gratitude is also extended to the Himachal Pradesh Electricity Regulatory Commission (HPERC) for making the documents like Tariff Order and Performance document public. The authors would like to express their gratitude to the two anonymous reviewers for their constructive comments on an earlier draft.

Funding: This research was funded by no specific funding agencies in public, commercial or not-for-profit sectors.

References

Andrews, R., Boyne, G.A. and Walker, R.M. (2012), "Organisational capacity and public service performance: a systematic review", Public Administration, Vol. 90 No. 3, pp. 756–771.

Barney, J.B. (1991), "Firm resources and sustained competitive advantage", Journal of Management, Vol. 17 No. 1, pp. 99–120.

Bhaskar, R. (1978), A Realist Theory of Science, Harvester Press, Brighton.

Bhatt, V. (2015), "Institutional constraints in electricity distribution reform in India", Economic and Political Weekly, Vol. 50 No. 22, pp. 45–53.

Bhattacharyya, S.C. (2013), "Financing energy access and off-grid electrification: a review of status, options and challenges", Renewable and Sustainable Energy Reviews, Vol. 20, pp. 462–472.

Central Electricity Authority (CEA) (2023), Annual Report on Power Sector Performance, Ministry of Power, Government of India, New Delhi.

Chatterjee, S. (2020), "Regulatory governance and the electricity sector in India: an analysis of UDAY", Energy Policy, Vol. 142, 111480.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation", Administrative Science Quarterly, Vol. 35 No. 1, pp. 128–152.

Dubash, N.K. and Rajan, S.C. (2001), "Power politics: process of India's power sector reform", Economic and Political Weekly, Vol. 36 No. 35, pp. 3367–3390.

Grindle, M.S. (1996), Challenging the State: Crisis and Innovation in Latin America and Africa, Cambridge University Press, Cambridge.

Guest, G., Bunce, A. and Johnson, L. (2006), "How many interviews are enough? An experiment with data saturation and variability", Field Methods, Vol. 18 No. 1, pp. 59–82.

Jain, A., Bhatt, M. and Sharma, R. (2022), "Distribution sector reforms and implementation gaps in Indian states", International Journal of Energy Sector Management, Vol. 16 No. 3, pp. 412–431.

Landis, J.R. and Koch, G.G. (1977), "The measurement of observer agreement for categorical data", Biometrics, Vol. 33 No. 1, pp. 159–174.

Miles, M.B., Huberman, A.M. and Saldaña, J. (2014), Qualitative Data Analysis: A Methods Sourcebook, 3rd ed., SAGE Publications, Thousand Oaks, CA.

Ministry of Power (2022), Revamped Distribution Sector Scheme: Scheme Guidelines, Government of India, New Delhi.

NITI Aayog (2021), India Energy Outlook 2021: Transforming India's Energy Future, Government of India, New Delhi.

North, D.C. (1990), Institutions, Institutional Change and Economic Performance, Cambridge University Press, Cambridge.

Patton, M.Q. (2002), Qualitative Research and Evaluation Methods, 3rd ed., SAGE Publications, Thousand Oaks, CA.

Planning Commission (2014), Twelfth Five-Year Plan (2012–2017): Energy, Government of India, New Delhi.

Prayas Energy Group (2023), Annual Integrated Rating and Ranking of Power Distribution Utilities, Prayas (Energy Group), Pune.

Ritchie, J. and Spencer, L. (1994), "Qualitative data analysis for applied policy research", in Bryman, A. and Burgess, R.G. (Eds), Analysing Qualitative Data, Routledge, London, pp. 173–194.

Rodríguez-Pose, A. (2013), "Do institutions matter for regional development?", Regional Studies, Vol. 47 No. 7, pp. 1034–1047.

Szulanski, G. (1996), "Exploring internal stickiness: impediments to the transfer of best practice within the firm", Strategic Management Journal, Vol. 17 No. S2, pp. 27–43.

Teece, D.J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management", Strategic Management Journal, Vol. 18 No. 7, pp. 509–533.

Tongia, R. (2003), "The political economy of Indian power sector reforms", Program on Energy and Sustainable Development Working Paper, Stanford University, Stanford, CA.

Wernerfelt, B. (1984), "A resource-based view of the firm", Strategic Management Journal, Vol. 5 No. 2, pp. 171–180.

Yin, R.K. (2018), Case Study Research and Design Methods, 6th ed., SAGE Publications, Thousand Oaks, CA.

Zahra, S.A. and George, G. (2002), "Absorptive capacity: a review, reconceptualisation, and extension", Academy of Management Review, Vol. 27 No. 2, pp. 185–203.