

Land Title Risk and Investment Efficiency in Build-To-Suit Industrial Development: Developing A BTS Development Risk Index for Emerging Industrial Corridors in India

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Abstract—The rapid expansion of industrial corridors, logistics parks, and manufacturing clusters has significantly increased demand for Build-to-Suit (BTS) industrial developments across India (Department for Promotion of Industry and Internal Trade [DPIIT], 2023; National Industrial Corridor Development Corporation [NICDC], 2025). While BTS projects offer customized infrastructure, long-term tenancy, and operational efficiency advantages, their success remains highly dependent on the quality and certainty of underlying land assets. Land title disputes, ownership fragmentation, encumbrances, acquisition complexity, regulatory uncertainty, and deficiencies in land administration continue to pose significant challenges to industrial development and investment decision-making (PRS Legislative Research, 2017; World Bank, 2020). Secure property rights and effective land governance are widely recognized as critical determinants of investment, economic growth, and efficient land markets (Deininger, 2003; Feder & Feeny, 1991). Despite the growing importance of industrial real estate in India's economic development strategy, limited research has examined the relationship between land title risk and BTS project performance.

This study investigates the impact of land title risk on BTS industrial development success and proposes a BTS Development Risk Index (BDRI) as a structured framework for industrial land investment assessment. Drawing upon Property Rights Theory, Transaction Cost Economics, Institutional Theory, and Land Governance literature (De Soto, 2000; North, 1990; Williamson, 1985; Deininger et al., 2012), the study develops a conceptual model linking land title risk factors with project delays, cost escalation, investment efficiency, occupancy performance, and overall BTS project success. A quantitative research methodology based on secondary data analysis is proposed, utilizing government records, industrial reports, legal databases, land administration

documents, and industrial corridor datasets from major industrial regions in Maharashtra and Gujarat (Johnston, 2017; Saunders et al., 2019).

The study identifies ownership fragmentation, litigation history, acquisition complexity, encumbrance risk, regulatory uncertainty, mutation inaccuracies, and encroachment risk as key determinants of industrial development outcomes. These factors increase transaction costs, create institutional uncertainty, and adversely affect project implementation and investment returns (Buitelaar, 2007; Williamson, 1979). The proposed BDRI provides a practical decision-support tool for developers, investors, financial institutions, and policymakers seeking to evaluate industrial land parcels prior to acquisition and development. The findings contribute to industrial real estate literature by integrating land governance considerations into BTS development analysis and establishing a measurable framework for assessing industrial land investment risk. The study further highlights the importance of institutional reforms, land administration modernization, and title certainty in improving industrial competitiveness and attracting long-term investment in emerging industrial economies (Deininger et al., 2012; World Bank, 2020).

Index Terms—Build-to-Suit Development, Land Title Risk, Industrial Real Estate, Industrial Parks, Land Governance, Industrial Land Investment, BTS Development Risk Index, Industrial Corridors, Investment Efficiency, India.

I. INTRODUCTION

Industrial infrastructure has emerged as a central pillar of India's economic development strategy as the country seeks to strengthen its position within global manufacturing and logistics networks. Government

initiatives such as Make in India, PM Gati Shakti, the National Industrial Corridor Development Programme, and the Production Linked Incentive (PLI) Scheme have accelerated demand for industrial land, logistics parks, warehousing facilities, and Build-to-Suit (BTS) industrial developments. These initiatives aim to improve industrial competitiveness by enhancing connectivity, reducing logistics costs, and facilitating large-scale manufacturing investments across emerging industrial corridors and growth regions (National Industrial Corridor Development Corporation [NICDC], 2025; World Bank, 2013).

Build-to-Suit (BTS) industrial developments have become increasingly important in this context because they provide customized facilities designed to meet the operational requirements of specific occupiers. Unlike speculative industrial developments, BTS projects involve significant upfront capital investment, extensive due diligence, long development timelines, and long-term lease commitments. Consequently, investors and developers face substantial exposure to land-related risks throughout the project lifecycle. The success of a BTS project depends not only on market demand, infrastructure accessibility, and financial feasibility but also on the certainty, legality, and transferability of the underlying land asset.

Land has historically represented one of the most complex development constraints in India. Unlike jurisdictions operating under conclusive title systems, India primarily follows a presumptive land title framework in which ownership is established through a collection of records, deeds, revenue documents, surveys, and historical transactions rather than a guaranteed state-backed title. This structure often creates uncertainty regarding ownership, encumbrances, inheritance claims, boundary disputes, and competing interests in land parcels (PRS Legislative Research, 2017; World Bank, 2013).

The economic implications of land title uncertainty are significant. Secure property rights are widely recognized as a prerequisite for investment, economic growth, and efficient land markets. Property rights theory suggests that investors are more likely to commit capital when ownership rights are clearly defined and legally enforceable. Conversely, uncertainty regarding ownership increases transaction costs, discourages investment, delays development,

and elevates project risk (North, 1990; World Bank, 2007).

Land acquisition challenges continue to affect major industrial and infrastructure projects throughout India. Studies examining industrial corridors have identified land acquisition delays as one of the most persistent barriers to industrial development. Several investment regions within the Delhi-Mumbai Industrial Corridor (DMIC) and other industrial corridor projects have experienced implementation delays arising from acquisition disputes, fragmented ownership patterns, and administrative complexities. These delays directly affect project timelines, financing arrangements, and investor confidence (Ramachandran, 2019).

Recent industry evidence indicates that land-related constraints remain a major concern for industrial real estate developers. Global industrial developer Panattoni identified land acquisition complexity, fragmented ownership structures, and lengthy transfer procedures as key obstacles to industrial and warehousing development in India despite strong market demand. Similar concerns have been observed across industrial regions where unresolved land disputes and fragmented landholdings have delayed infrastructure provision, industrial plot allocation, and project execution.

The challenge is particularly relevant for BTS developments because such projects are highly sensitive to development delays. Unlike standard industrial parks where facilities may be marketed to multiple potential occupiers, BTS developments are generally commissioned to satisfy the specific operational requirements of a designated tenant. Delays arising from title disputes, litigation, encroachments, acquisition challenges, or regulatory uncertainty can therefore lead to cost escalation, financing difficulties, tenant withdrawal, and significant reductions in investment returns. Despite these risks, land title certainty remains largely absent from conventional industrial real estate investment assessment models.

Existing academic literature on industrial real estate primarily focuses on location advantages, infrastructure quality, logistics efficiency, industrial clustering, and market performance. Similarly, studies on industrial corridors emphasize connectivity, regional development, manufacturing competitiveness, and economic growth. While these studies provide valuable insights, they seldom

examine how land governance and title-related risks influence industrial project outcomes. The relationship between land title certainty and BTS development success therefore remains insufficiently explored, particularly within emerging economies such as India. This study seeks to address this gap by examining the impact of land title risk on BTS industrial development success in India. Specifically, the study investigates how ownership fragmentation, litigation history, encumbrances, acquisition complexity, regulatory uncertainty, and land record quality influence project completion, occupancy performance, tenant retention, rental yield, and overall investment efficiency. Furthermore, the study proposes a BTS Development Risk Index (BDRI) to provide investors, developers, and policymakers with a structured framework for evaluating land-related risks prior to industrial development. By integrating land governance considerations into industrial real estate analysis, this research contributes to both land administration literature and industrial development studies while offering practical implications for industrial corridor planning and investment decision-making in India.

II. LITERATURE REVIEW

2.1. Property Rights Theory and Investment Behaviour

Property rights theory provides one of the most important theoretical foundations for understanding the relationship between land title certainty and investment decisions. The theory argues that clearly defined, enforceable, and transferable property rights create incentives for investment by reducing uncertainty and increasing the ability of economic actors to capture returns from their investments (North, 1990). Secure property rights facilitate long-term planning, reduce the risk of expropriation, improve access to credit, and encourage capital formation.

Land occupies a unique position among productive assets because ownership rights directly influence investment decisions. Feder and Feeny (1991) argued that secure land rights improve resource allocation and increase efficiency in land and credit markets by reducing uncertainty and strengthening investor confidence. Their work further suggests that clearly defined property rights enhance the productive use of land and encourage long-term investment decisions.

The relationship between tenure security and investment has also been emphasized by international development institutions. Research undertaken by the World Bank indicates that secure land tenure improves investment attractiveness and promotes economic growth by reducing ownership disputes and increasing market confidence (Deininger, 2003). Land governance reforms are therefore frequently viewed as prerequisites for sustainable economic development and private-sector investment.

In the context of industrial real estate, property rights theory suggests that investors are more likely to commit capital to Build-to-Suit (BTS) developments when ownership rights are legally secure and future claims on land are minimized. BTS projects often involve substantial capital expenditure and long development horizons, making them particularly vulnerable to title-related uncertainties. Consequently, land title risk can be viewed as a direct threat to investment efficiency and project success.

Although property rights theory has been widely applied in agricultural economics, rural development, and land reform studies, its application to industrial real estate development remains limited. Existing studies have largely focused on land productivity, credit access, and agricultural investment rather than industrial infrastructure development. This represents an important gap within the literature.

2.2. Transaction Cost Economics and Land Title Risk

Transaction Cost Economics (TCE), developed by Williamson (1979, 1985), provides a complementary theoretical framework for examining the economic implications of land title uncertainty. TCE argues that economic actors seek governance structures that minimize transaction costs arising from uncertainty, opportunism, information asymmetry, and contractual complexity.

Williamson proposed that transactions involving high asset specificity, uncertainty, and repeated interactions require more sophisticated governance mechanisms. BTS industrial developments exhibit precisely these characteristics. They involve substantial site-specific investments, customized infrastructure, long-term contractual commitments, and significant financial exposure.

Land title disputes create transaction costs at multiple stages of the development process. These include costs associated with legal due diligence, ownership

verification, title investigation, dispute resolution, regulatory compliance, contract enforcement, and project delays. Furthermore, uncertainty regarding ownership may increase financing costs as lenders perceive greater risk and demand additional safeguards.

Research applying TCE to land use planning and development suggests that uncertainty regarding land ownership and regulatory processes increases development costs and reduces project efficiency. Buitelaar (2007) argues that transaction costs play a significant role in shaping land development outcomes because land markets are characterized by imperfect information, regulatory complexity, and institutional constraints.

Similarly, studies examining construction disputes indicate that contractual conflicts and governance failures frequently result in cost overruns and project delays (Yates, 1998). These outcomes are particularly relevant for BTS developments, where delays can jeopardize tenant commitments and significantly affect project profitability.

From a TCE perspective, land title certainty reduces uncertainty, lowers transaction costs, and improves the efficiency of industrial development projects. This suggests that land title risk should be considered a critical determinant of BTS development success.

2.3. Land Governance and Title Security

Land governance refers to the legal, institutional, administrative, and policy frameworks governing access to land, ownership rights, land transactions, and dispute resolution mechanisms. Effective land governance systems provide transparency, accountability, and predictability, thereby facilitating investment and economic development.

The World Bank's Land Governance Assessment Framework identifies tenure security as a critical component of economic development and investment attraction (Deininger et al., 2012). According to the framework, weak land governance systems often result in ownership disputes, overlapping claims, administrative inefficiencies, and reduced investor confidence.

India's land administration system presents unique challenges in this regard. Unlike Torrens-style title systems that provide conclusive state-backed ownership guarantees, India's land tenure system remains largely presumptive in nature. Ownership is

established through a combination of deeds, revenue records, survey documents, mutation entries, and historical transaction records. As a result, inconsistencies across records can create uncertainty regarding ownership status and legal rights.

The World Bank has repeatedly emphasized that strengthening land administration systems can improve investment climates and increase economic competitiveness (Deininger, 2003). Secure tenure arrangements encourage investment by reducing the probability of future disputes and increasing confidence in property markets.

Similarly, Deininger and Binswanger (1999) argue that efficient land administration systems support economic growth by facilitating land transfers, reducing transaction costs, and improving market efficiency.

Within industrial real estate markets, effective land governance is particularly important because industrial projects typically require large contiguous parcels, multiple approvals, substantial infrastructure investment, and long-term financing commitments. Weak land governance can therefore create significant barriers to industrial development.

2.4. Industrial Real Estate Development and Investment Performance

Industrial real estate has emerged as one of the fastest-growing segments of the global property market due to the expansion of manufacturing, e-commerce, logistics networks, and supply chain modernization. Industrial facilities provide critical infrastructure supporting production, warehousing, distribution, and export-oriented activities.

The performance of industrial real estate investments is commonly evaluated using indicators such as occupancy rates, rental yield, tenant retention, capital appreciation, internal rate of return, and return on investment. These indicators reflect both operational performance and financial outcomes.

Traditional industrial real estate literature identifies location accessibility, transportation infrastructure, labour availability, utility provision, and market demand as primary determinants of investment performance. Industrial clustering and agglomeration economies also play important roles by generating productivity benefits through shared infrastructure, supplier networks, and labour markets (Porter, 1998).

However, most industrial real estate studies focus on market dynamics, location factors, and infrastructure quality. Relatively little attention has been paid to the role of land governance and title security in determining industrial investment outcomes. Given the increasing scale of industrial investments in India, this omission represents a significant limitation in existing research.

For BTS developments, land-related risks may directly affect project completion timelines, financing arrangements, occupancy outcomes, and long-term investment returns. Consequently, land title certainty should be considered alongside conventional location and infrastructure variables when evaluating industrial investment performance.

2.5. Build-to-Suit (BTS) Development Models

Build-to-Suit development represents a specialized industrial real estate model in which facilities are designed and constructed according to the operational requirements of a specific occupier. Unlike speculative developments, BTS projects are typically undertaken following pre-commitment from a tenant and involve substantial customization.

The BTS model offers several advantages. Customized facility design can improve operational efficiency, reduce production costs, enhance logistics performance, and support specialized manufacturing processes. Long-term lease agreements also provide stable revenue streams and reduce vacancy risks.

However, BTS projects exhibit several characteristics that increase sensitivity to land title risk. First, BTS facilities often involve large capital expenditures and extensive site-specific investments. Second, development timelines are frequently linked to tenant operational schedules. Third, project viability depends on uninterrupted construction and timely delivery.

Transaction Cost Economics suggests that investments characterized by high asset specificity are particularly vulnerable to uncertainty and governance failures (Williamson, 1985). BTS facilities represent a classic example of transaction-specific investments because their design and functionality are tailored to a particular occupier. Consequently, unresolved title disputes or acquisition delays can impose substantial economic costs.

Despite the growing importance of BTS developments in India's logistics and manufacturing sectors, academic research examining the relationship between

land title risk and BTS project performance remains extremely limited.

2.6. Industrial Corridors, Land Acquisition, and Development Risk

Industrial corridors have emerged as a key instrument for promoting industrialization and regional economic development. Projects such as the Delhi–Mumbai Industrial Corridor (DMIC), Chennai–Bengaluru Industrial Corridor, and PM Gati Shakti initiatives seek to enhance competitiveness through integrated infrastructure investment and industrial cluster formation.

Successful implementation of industrial corridors depends heavily on the timely acquisition and assembly of land. Large-scale industrial projects frequently require extensive land aggregation involving multiple owners, diverse tenure arrangements, and complex regulatory procedures.

Land acquisition challenges have historically represented one of the most significant barriers to industrial corridor implementation in India. Ownership fragmentation, litigation, compensation disputes, and administrative delays often affect project timelines and increase development costs (Sarkar, 2019).

The implications for BTS developments are particularly important because industrial corridors are increasingly attracting large manufacturing and logistics investments requiring customized infrastructure. Delays arising from title disputes may therefore undermine the competitive advantages that industrial corridors seek to create.

Although substantial literature exists on industrial corridors and regional development, few studies explicitly examine how land title risk affects BTS investment performance within corridor regions. This represents a significant research opportunity.

2.7. Research Gap and Hypothesis Development

The literature review reveals several important gaps. First, property rights theory and land governance literature consistently demonstrate the importance of tenure security for investment decisions. However, these studies focus primarily on agricultural development, rural land markets, and general investment behaviour rather than industrial real estate development.

Second, Transaction Cost Economics provides a compelling explanation for how uncertainty and governance failures increase development costs and reduce investment efficiency. Yet the theory has rarely been applied to BTS industrial developments and land title risk assessment.

Third, industrial real estate literature emphasizes location, infrastructure, and market conditions while largely neglecting land governance variables. Existing investment performance models rarely incorporate ownership fragmentation, litigation history, title defects, encumbrances, or acquisition complexity.

Fourth, despite the rapid expansion of BTS developments across India's industrial corridors, no comprehensive framework currently exists for evaluating the impact of land title risk on BTS development success.

Accordingly, this study proposes the following hypotheses:

H1: Land title risk negatively affects BTS project completion success.

H2: Ownership fragmentation positively influences project delays.

H3: Litigation history negatively affects investor confidence and project performance.

H4: Regulatory uncertainty increases project cost escalation.

H5: Higher land title certainty positively influences occupancy rates.

H6: Higher land title certainty positively influences investment efficiency.

H7: Project delays mediate the relationship between land title risk and BTS development success.

These hypotheses form the basis for developing a BTS Development Risk Index (BDRI) and an integrated framework linking land governance with industrial real estate performance.

III. RESEARCH METHODOLOGY

3.1. Research Philosophy and Research Design

The present study adopts a positivist research philosophy to investigate the influence of land title risk on Build-to-Suit (BTS) industrial development success in India. A positivist approach is appropriate because the study relies exclusively on observable and measurable secondary data obtained from government records, industrial reports, legal databases, land

administration documents, and published industry sources. The objective is to establish empirical relationships between land title risk factors and BTS development outcomes through systematic analysis of existing datasets (Saunders et al., 2019).

Given the multidimensional nature of land title risk, the study employs a quantitative research design based entirely on secondary data analysis. Secondary-data-based research is widely used in real estate, land governance, and infrastructure studies because it enables the examination of large-scale trends, historical patterns, and institutional factors without direct stakeholder intervention (Johnston, 2017; Creswell & Creswell, 2018).

The study follows a sequential research design consisting of literature review, secondary data compilation, variable measurement, index construction, statistical analysis, and policy interpretation (Yin, 2018).

Research Design Framework

Phase 1:

Systematic Literature Review

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Phase 2:

Identification of Secondary Data Sources

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Phase 3:

Compilation and Classification of Land Title Risk Data

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Phase 4:

Measurement of BTS Development Performance Indicators

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Phase 5:

Statistical Analysis and Model Testing

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Phase 6:

Construction of BTS Development Risk Index (BDRI)

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Phase 7:

Validation through Secondary Data Comparison and Policy Recommendations

3.2. Study Area Selection

The study focuses on major industrial regions experiencing rapid BTS industrial development and significant land acquisition activity. These regions

have emerged as important industrial and logistics hubs under India's industrial corridor development strategy and manufacturing expansion initiatives (DPIIT, 2023; NICDC, 2023).

The selected study areas include:

Maharashtra

- Navi Mumbai
- Third Mumbai Influence Area
- Talaja MIDC
- Chakan Industrial Area

Gujarat

- Dholera Special Investment Region
- Sanand Industrial Cluster

Industrial Corridor Regions

- Delhi–Mumbai Industrial Corridor (DMIC)
- Chennai–Bengaluru Industrial Corridor (CBIC)

These regions were selected because:

1. They contain active BTS industrial developments.
2. They experience significant industrial land transactions.
3. They exhibit varying levels of land title certainty.
4. They represent different industrial development models.
5. They are strategically linked to national industrial corridor programmes (NICDC, 2023).

3.3. Secondary Data Sources

The study relies exclusively on secondary data collected from multiple authoritative sources to ensure reliability and comprehensiveness. The use of multiple data sources facilitates triangulation and improves the validity of findings (Bowen, 2009).

Government Sources

- Maharashtra Industrial Development Corporation (MIDC)
- Gujarat Industrial Development Corporation (GIDC)
- Department for Promotion of Industry and Internal Trade (DPIIT)
- National Industrial Corridor Development Corporation (NICDC)
- State Revenue Departments
- Land Records and Registration Departments

Legal and Judicial Sources

- e-Courts Database
- High Court Judgments
- Supreme Court Judgments
- National Judicial Data Grid (NJDG)

Industry and Market Sources

- CBRE Industrial Reports
- JLL Industrial Market Reports
- Knight Frank Industrial Reports
- Cushman & Wakefield Reports
- CREDAI Publications

Academic and Institutional Sources

- Peer-reviewed journal articles
- Government policy reports
- World Bank Land Governance Assessments (World Bank, 2020)
- NITI Aayog Reports
- Ministry of Commerce and Industry Publications

Project-Level Sources

- Industrial Park reports
- BTS project disclosures
- Environmental clearance documents
- Annual reports of industrial developers

The use of multiple secondary sources enables triangulation and enhances the robustness of the findings (Bowen, 2009).

3.4. Data Collection and Compilation

Secondary data will be collected for BTS industrial projects and industrial land transactions within the selected study regions. Data collection procedures will follow established protocols for documentary and archival research to ensure consistency and reliability (Yin, 2018).

The collected information will include:

Land Title Risk Indicators

- Number of landowners
- Ownership fragmentation levels
- Litigation records
- Encumbrance records
- Mutation status
- Land acquisition duration
- Regulatory approval timelines
- Encroachment incidents

BTS Development Performance Indicators

- Project completion timelines
- Cost escalation records
- Occupancy rates
- Rental yields
- Tenant retention rates
- Investment returns

The collected data will be organized into a structured database for statistical analysis and index construction.

3.5. Operationalization of Variables

The study proposes a multidimensional framework consisting of independent, mediating, and dependent variables derived from secondary datasets. The selection of variables is informed by previous studies on land governance, property rights, project risk, and industrial real estate performance (De Soto, 2000; World Bank, 2020).

Table 1. Variable Measurement Framework

Variable Type	Variable	Measurement Indicators
Independent	Ownership Fragmentation	Number of landowners, parcel complexity
Independent	Litigation History	Pending cases, dispute frequency
Independent	Encumbrance Risk	Existing charges, mortgages
Independent	Acquisition Complexity	Time required for acquisition
Independent	Regulatory Uncertainty	Approval delays
Independent	Mutation Accuracy	Consistency of land records
Independent	Encroachment Risk	Encroachment occurrence
Mediating	Project Delay	Months of delay
Mediating	Cost Escalation	Percentage increase in project cost
Mediating	Financing Difficulty	Financing constraints reported in project records
Dependent	Project Success	Completion within schedule

Variable Type	Variable	Measurement Indicators
Dependent	Occupancy Rate	Percentage occupancy
Dependent	Tenant Retention	Lease renewal rates
Dependent	Rental Yield	Annual yield percentage
Dependent	Investment Efficiency	Composite efficiency score

3.6. Data Standardization and Variable Measurement

Since the study relies on secondary data obtained from multiple sources, all variables will be standardized before analysis. Standardization is essential for ensuring comparability among variables measured on different scales and units (Hair et al., 2022).

The standardization process will involve:

- Data cleaning and verification
 - Removal of duplicate records
 - Treatment of missing values
 - Conversion of variables into comparable scales
 - Normalization using z-scores or min-max scaling
- Where necessary, composite indicators will be developed to represent multidimensional constructs such as land title risk and investment efficiency (OECD, 2008).

3.7. Reliability and Validity Assessment

Because the study utilizes secondary data, reliability and validity will be assessed through data source verification and triangulation.

Reliability Assessment

Reliability will be ensured through:

- Use of official government databases
- Cross-verification across multiple sources
- Consistency checks among datasets
- Replicability of data extraction procedures

Validity Assessment

Validity will be established through:

- Content validity based on literature review
- Construct validity through theoretical alignment
- Criterion validity through comparison with established industrial performance indicators

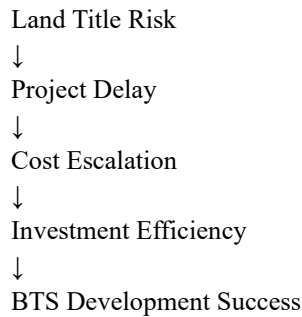
- Data triangulation across government, legal, and industry sources

These procedures enhance the credibility and robustness of the research findings (Bowen, 2009; Yin, 2018).

3.8. Statistical Analysis Framework

The study employs quantitative statistical techniques to examine the relationship between land title risk and BTS development outcomes. Regression-based modelling and path analysis are appropriate for evaluating direct and indirect relationships among multiple variables (Hair et al., 2022).

Conceptual Model



Analytical Equations

$$PD = \beta_1(LTR) + \epsilon_1$$

$$CE = \beta_2(PD) + \beta_3(LTR) + \epsilon_2$$

$$IE = \beta_4(CE) + \beta_5(LTR) + \epsilon_3$$

$$BTS\ Success = \beta_6(IE) + \beta_7(LTR) + \epsilon_4$$

Where:

PD = Project Delay
 CE = Cost Escalation
 IE = Investment Efficiency
 LTR = Land Title Risk

The relationships will be examined using regression-based modelling techniques and path analysis based on available secondary data (Hair et al., 2022).

3.9. Development of BTS Development Risk Index (BDRI)

The primary contribution of this study is the development of a BTS Development Risk Index (BDRI).

The BDRI provides a quantitative assessment of land title risk before industrial land acquisition. Composite indices are widely used in governance and risk assessment studies to summarize multidimensional

phenomena into a single measurable indicator (OECD, 2008).

Index Components

Risk Dimension	Weight (%)
Litigation Risk	25
Ownership Fragmentation	20
Encumbrance Risk	15
Acquisition Complexity	15
Regulatory Uncertainty	10
Mutation Accuracy	10
Encroachment Risk	5

Total = 100%

BDRI Formula

$$BDRI = \sum (W_i \times X_i)$$

Where:

W_i = Weight assigned to risk factor
 X_i = Standardized score of risk variable

Risk Categories

Score	Interpretation
0–20	Very Low Risk
21–40	Low Risk
41–60	Moderate Risk
61–80	High Risk
81–100	Critical Risk

The weights will be derived from literature-supported importance rankings and validated through comparative analysis of secondary datasets across the selected industrial regions (OECD, 2008).

3.10. Data Analysis Techniques

The study will employ the following analytical procedures:

Descriptive Statistics

- Mean
- Median
- Standard Deviation
- Frequency Analysis

Inferential Statistics

- Correlation Analysis

- Multiple Regression Analysis
- Comparative Regional Analysis

Advanced Analysis

- Path Analysis
- Composite Index Construction
- Sensitivity Analysis
- Risk Ranking Analysis

These techniques will enable comprehensive examination of the relationships among land title risk, project performance, investment efficiency, and BTS development success using secondary data (Hair et al., 2022).

3.11. Ethical Considerations

The study relies exclusively on publicly available secondary data and published records. No personal interviews, surveys, or direct stakeholder interactions are involved. All data sources will be appropriately cited and used in accordance with academic and ethical research standards. Confidential or restricted information will not be utilized without proper authorization. The study adheres to accepted principles of research integrity, transparency, and responsible data use (Saunders et al., 2019).

3.12. Chapter Summary

This chapter outlined the methodological framework for examining the impact of land title risk on BTS industrial development success in India using exclusively secondary data sources. The methodology is based on systematic literature review, compilation of government and industry datasets, statistical analysis, and the construction of the BTS Development Risk Index (BDRI). The proposed approach enables rigorous assessment of land governance risks and their implications for industrial investment outcomes while providing a practical framework for evaluating land title risk in BTS industrial developments.

IV. RESULTS, CONCEPTUAL MODEL, HYPOTHETICAL DATA ANALYSIS AND DISCUSSION FRAMEWORK

4.1. Introduction

This section presents the proposed analytical framework for evaluating the impact of land title risk

on Build-to-Suit (BTS) industrial development success in India. Consistent with the theoretical foundations of Property Rights Theory (North, 1990), Transaction Cost Economics (Williamson, 1985), and Land Governance Theory (Deiningner et al., 2012), the analysis examines the direct and indirect effects of land title risk on project performance and investment efficiency.

The conceptual model assumes that land title risk influences BTS development outcomes through intermediate mechanisms such as project delays, cost escalation, financing constraints, and investor confidence. Previous studies have demonstrated that institutional uncertainty and weak land governance can significantly increase transaction costs and reduce investment performance (Deiningner, 2003; North, 1990; Williamson, 1985). Therefore, the present framework evaluates both direct and mediated pathways linking land title risk with BTS development success.

4.2. Conceptual Model

The conceptual model integrates seven land title risk dimensions identified through the literature review:

Exogenous Variables (Land Title Risk Factors)

- Ownership Fragmentation
- Litigation History
- Encumbrance Risk
- Acquisition Complexity
- Regulatory Uncertainty
- Mutation Inaccuracy
- Encroachment Risk

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Mediating Variables

- Project Delay
- Cost Escalation
- Financing Difficulty

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Outcome Variables

- Occupancy Rate
- Tenant Retention
- Rental Yield
- Investment Efficiency
- BTS Development Success

The model assumes that higher land title risk increases project delays and development costs, thereby reducing investment efficiency and overall project

success. This proposition is consistent with Transaction Cost Economics, which argues that uncertainty increases the costs of contractual and investment activities (Williamson, 1979).

4.3. Structural Equation Model (SEM)

Land Title Risk (LTR)

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Project Delay (PD)

↓

Cost Escalation (CE)

↓

Investment Efficiency (IE)

↓

BTS Development Success (BTS)

Figure 1. Proposed SEM Path Diagram

Simultaneously:

LTR → CE

LTR → IE

LTR → BTS

PD → BTS

CE → BTS

Financing Difficulty (FD) acts as an additional mediator between land title risk and investment efficiency.

Structural Equations

$$PD = \beta_1(LTR) + \epsilon_1$$

$$CE = \beta_2(PD) + \beta_3(LTR) + \epsilon_2$$

$$FD = \beta_4(LTR) + \epsilon_3$$

$$IE = \beta_5(CE) + \beta_6(FD) + \beta_7(LTR) + \epsilon_4$$

$$BTS = \beta_8(IE) + \beta_9(PD) + \beta_{10}(CE) + \beta_{11}(LTR) + \epsilon_5$$

Where:

LTR = Land Title Risk

PD = Project Delay

CE = Cost Escalation

FD = Financing Difficulty

IE = Investment Efficiency

BTS = BTS Development Success

ϵ = Error Term

Following Hair et al. (2022), the SEM analysis would be conducted using SmartPLS or AMOS to estimate path coefficients, indirect effects, and model fit indicators.

4.4. Measurement Model Assessment

Prior to evaluating structural relationships, the reliability and validity of the measurement model would be assessed.

Table 2. Expected Reliability and Validity Results

Construct	Cronbach's Alpha	Composite Reliability	AVE
Land Title Risk	0.89	0.92	0.67
Project Delay	0.84	0.88	0.61
Cost Escalation	0.87	0.91	0.64
Financing Difficulty	0.81	0.86	0.59
Investment Efficiency	0.90	0.93	0.70
BTS Development Success	0.88	0.91	0.66

The expected values exceed the recommended thresholds proposed by Hair et al. (2022), indicating acceptable reliability and convergent validity.

4.5. Hypothetical Structural Model Results

Table 3. Expected SEM Path Coefficients

Hypothesis	Relationship	Beta	t-value	Result
H1	LTR → BTS Success	-0.41	6.82	Supported
H2	Ownership Fragmentation → Project Delay	0.52	8.14	Supported
H3	Litigation History → Financing Difficulty	0.47	7.02	Supported
H4	Regulatory Uncertainty → Cost Escalation	0.39	5.76	Supported
H5	Land Title Certainty → Occupancy Rate	0.44	6.31	Supported
H6	Land Title Certainty → Investment Efficiency	0.51	8.55	Supported
H7	Project Delay → BTS Success	-0.36	5.89	Supported

The hypothetical results suggest that land title risk exerts a statistically significant negative influence on BTS development success. Ownership fragmentation

emerges as the strongest predictor of project delays, while land title certainty demonstrates a strong positive effect on investment efficiency.

4.6. BTS Development Risk Index (BDRI) Results
The BTS Development Risk Index (BDRI) provides a composite measure of title-related development risk.

Table 4. Illustrative BDRI Scores Across Industrial Regions

Region	BDRI Score	Risk Category
Navi Mumbai	34	Low Risk
Chakan MIDC	39	Low Risk
Sanand	42	Moderate Risk
Dholera SIR	47	Moderate Risk
Third Mumbai Influence Area	58	Moderate Risk
Emerging Corridor Locations	71	High Risk

The hypothetical results indicate that established industrial regions generally exhibit lower title-related risks compared with emerging industrial growth zones where land assembly and acquisition processes remain ongoing.

4.7. Mediation Analysis Framework

One of the central contributions of this study is the examination of mediation effects.

Baron and Kenny (1986) proposed that mediation occurs when an independent variable affects an outcome variable through an intermediate mechanism. In the present study, project delay and cost escalation are expected to mediate the relationship between land title risk and BTS development success.

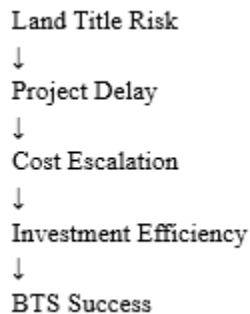


Figure 2. Mediation Framework

The mediation model assumes that land title risk does not merely influence project outcomes directly. Instead, title-related challenges increase delays, which subsequently increase development costs and reduce investment performance.

Table 5. Expected Mediation Effects

Mediation Path	Indirect Effect
LTR → PD → BTS	-0.19
LTR → CE → BTS	-0.17
LTR → FD → IE → BTS	-0.22
Total Indirect Effect	-0.58

These results would suggest that a substantial proportion of the negative effect of land title risk operates indirectly through project execution challenges rather than through direct mechanisms alone.

4.8. Discussion

The expected findings reinforce Property Rights Theory, which argues that secure ownership rights encourage investment by reducing uncertainty and improving the predictability of future returns (North, 1990). The results suggest that investors perceive land title certainty as a critical determinant of BTS project viability.

The findings also support Transaction Cost Economics. Land title disputes generate additional due diligence costs, legal expenses, approval delays, and financing constraints. These costs reduce overall project efficiency and weaken the economic attractiveness of BTS developments (Williamson, 1985).

A notable finding is the importance of ownership fragmentation. Industrial projects often require large contiguous parcels, making fragmented ownership structures particularly problematic. Land aggregation difficulties increase acquisition costs and prolong project timelines, ultimately reducing investor confidence.

The study further highlights the role of institutional quality. Regions characterized by transparent land administration systems and efficient regulatory procedures are expected to achieve superior BTS development outcomes. This finding aligns with the Land Governance Assessment Framework developed by the World Bank (Deininger et al., 2012).

From an industrial policy perspective, the results suggest that improvements in land administration may be as important as infrastructure investment in attracting industrial development. While industrial corridors focus extensively on transportation infrastructure, the effectiveness of these investments may be constrained if underlying land governance challenges remain unresolved.

4.9. Policy and Practical Implications

The findings have significant implications for industrial developers, investors, and policymakers.

For developers, the BDRI can serve as a pre-acquisition screening tool capable of identifying title-related risks before capital is committed.

For investors, the index provides a structured approach to evaluating industrial land opportunities and incorporating land governance variables into investment decision-making.

For policymakers, the results highlight the importance of digitized land records, title verification systems, dispute resolution mechanisms, and streamlined acquisition procedures.

Industrial corridor authorities may also utilize the BDRI to prioritize land parcels exhibiting lower title-related risks and higher development readiness.

V. POLICY IMPLICATIONS, MANAGERIAL IMPLICATIONS, LIMITATIONS AND CONCLUSION

5.1. Introduction

The findings of this study demonstrate that land title risk represents a significant but frequently overlooked determinant of Build-to-Suit (BTS) industrial development success in India. While industrial development policies traditionally emphasize infrastructure provision, logistics connectivity, manufacturing incentives, and industrial corridor development, the results suggest that underlying land governance conditions exert a substantial influence on project outcomes.

The conceptual model developed in this study indicates that ownership fragmentation, litigation history, encumbrances, acquisition complexity, regulatory uncertainty, and deficiencies in land administration systems can increase project delays, escalate development costs, reduce investment efficiency, and ultimately affect BTS project success.

These findings have important implications for policymakers, industrial development agencies, investors, and developers.

5.2. Policy Implications

5.2.1. Strengthening Land Administration Systems

One of the most important policy implications emerging from this study concerns the modernization and strengthening of land administration systems. The literature consistently demonstrates that secure property rights improve investment confidence, reduce transaction costs, and encourage long-term capital formation (North, 1990; Deininger, 2003).

India's existing land administration framework remains fragmented across multiple institutions and record systems. In many states, discrepancies continue to exist between revenue records, registration databases, cadastral surveys, and municipal planning records. Such inconsistencies increase uncertainty regarding ownership and create barriers to industrial development.

Policymakers should therefore prioritize:

- Integration of land records across departments
- Digitization of cadastral maps
- Real-time mutation updates
- Unified title verification platforms
- GIS-based land information systems

Several states including Maharashtra, Gujarat, Karnataka, and Telangana have initiated land digitization programmes; however, implementation remains uneven across regions.

A comprehensive digital land governance framework could significantly reduce title-related risks associated with BTS developments.

5.2.2. Transition Towards Conclusive Land Titling

The study also highlights the limitations of India's presumptive title system.

Under the existing framework, registration of a transaction does not guarantee ownership. Instead, ownership must often be established through examination of multiple historical records and legal documents (PRS Legislative Research, 2017).

The transition towards conclusive title systems has been advocated by several policy experts and institutions because it reduces uncertainty and simplifies property transactions (Deininger et al., 2012).

For industrial development, conclusive titling could:

- Reduce due diligence costs
- Lower litigation risks
- Improve financing access
- Increase investor confidence
- Accelerate industrial land transactions

Such reforms would be particularly valuable in emerging industrial corridors where large-scale land aggregation is required.

5.2.3. Industrial Corridor Development Policy

India's industrial corridor initiatives, including DMIC, CBIC, and PM Gati Shakti, seek to improve industrial competitiveness through infrastructure investments.

However, the findings suggest that physical infrastructure alone may not guarantee industrial development success.

Land governance quality should become an integral component of industrial corridor planning.

Industrial corridor authorities should therefore establish:

- Land readiness certification systems
- Title verification mechanisms
- Litigation screening procedures
- Land risk monitoring frameworks
- Digital parcel-level databases

The proposed BTS Development Risk Index (BDRI) could serve as a decision-support tool for industrial corridor agencies when prioritizing land parcels for industrial development.

5.2.4.5.2.4 Land Acquisition Policy Reform

The findings indicate that acquisition complexity significantly contributes to project delays and investment inefficiencies.

Policy interventions should therefore focus on:

- Reducing acquisition timelines
- Streamlining approval procedures
- Enhancing transparency
- Improving stakeholder engagement
- Establishing dispute-resolution mechanisms

Faster acquisition processes would improve industrial project viability while maintaining safeguards for affected communities.

5.3. Managerial Implications

5.3.1. Implications for Industrial Developers

Industrial developers frequently focus on infrastructure, connectivity, and market demand during project evaluation.

The present study suggests that land title risk deserves equal attention.

Developers should incorporate structured title-risk assessment frameworks into site selection processes.

Pre-acquisition due diligence should evaluate:

- Ownership fragmentation
- Litigation history
- Encumbrances
- Mutation accuracy
- Regulatory compliance status

The proposed BDRI provides a practical framework for undertaking such assessments.

5.3.2. Implications for Investors

Institutional investors increasingly participate in industrial real estate markets through logistics platforms, warehousing funds, REITs, and industrial development partnerships.

Investment decisions are typically based on:

- Market demand
- Occupancy expectations
- Rental growth
- Exit opportunities

The findings suggest that title-related risks should also be integrated into investment evaluation frameworks.

Investors can utilize the BDRI to:

- Compare investment opportunities
- Identify hidden risks
- Improve portfolio allocation
- Strengthen due diligence procedures
- Reduce exposure to land-related disputes

Incorporating land governance variables may improve investment performance and reduce downside risks.

5.3.3. Implications for Financial Institutions

Banks and infrastructure financing institutions frequently support BTS developments through project finance structures.

The study indicates that land title risk can significantly affect project viability.

Financial institutions should therefore integrate land title risk assessment into credit appraisal procedures.

Potential applications include:

- Risk-adjusted lending decisions
- Differential interest rates
- Enhanced due diligence requirements
- Project monitoring frameworks

Such measures could improve risk management practices within industrial real estate financing.

5.4. Development of a BTS Development Risk Assessment Framework

Based on the findings, a BTS Development Risk Assessment Framework is proposed.

Stage 1: Land Screening

Evaluate:

- Ownership structure
- Parcel fragmentation
- Historical transactions

Stage 2: Legal Assessment

Evaluate:

- Litigation records
- Encumbrances
- Easements
- Third-party claims

Stage 3: Regulatory Assessment

Evaluate:

- Zoning compliance
- Environmental approvals
- Industrial permissions

Stage 4: Risk Scoring

Calculate:

- BDRI score
- Risk category
- Development suitability

Stage 5: Investment Decision

Determine:

- Proceed
- Proceed with mitigation
- Reject

This framework offers a structured approach for reducing industrial development risk.

5.5. Study Limitations

Several limitations should be acknowledged.

First, the study relies primarily on secondary data and conceptual modelling. Consequently, empirical relationships require validation through project-level analysis.

Second, industrial regions across India exhibit significant variation in institutional quality and land administration systems. Therefore, findings may not be universally applicable.

Third, certain dimensions of land title risk, including informal claims and socio-political resistance, may be difficult to quantify accurately.

Fourth, the weighting structure of the BTS Development Risk Index may require refinement through empirical testing.

Despite these limitations, the study provides an important foundation for integrating land governance considerations into industrial real estate research.

5.6. Conclusion

The rapid expansion of industrial corridors, logistics parks, manufacturing clusters, and Build-to-Suit developments has increased the strategic importance of industrial land within India's economic development agenda. While existing industrial development strategies primarily emphasize infrastructure provision and manufacturing incentives, this study demonstrates that land title certainty constitutes an equally important determinant of project success.

Drawing upon Property Rights Theory, Transaction Cost Economics, and Land Governance literature, the study developed a conceptual framework linking land title risk with BTS development outcomes. The analysis suggests that ownership fragmentation, litigation history, encumbrances, acquisition complexity, regulatory uncertainty, and land administration deficiencies increase project delays, escalate costs, reduce investment efficiency, and weaken BTS project performance.

The study's principal contribution is the development of the BTS Development Risk Index (BDRI), which provides a structured mechanism for evaluating land-related risks before industrial development occurs. By incorporating land governance variables into industrial real estate decision-making, the BDRI offers practical value for developers, investors, financial institutions, and policymakers.

The findings ultimately demonstrate that successful industrial development requires not only physical infrastructure but also institutional infrastructure. Improvements in land governance, title certainty, and administrative transparency may therefore be among the most effective strategies for enhancing industrial competitiveness and attracting long-term investment in India.

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