A Data-Driven Assessment Model for the Adaptive Reuse Potential of Industrial Heritage Buildings

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Abstract: This study develops a data-driven model to assess the adaptive reuse potential of industrial heritage buildings using 18,194 listed assets in England. The framework combines statutory grade, transport accessibility, brownfield proximity, conservation clustering, and designation age into a composite reuse index and a logistic classification of high-potential cases. The mean reuse score is 0.515 and 30.0% of assets fall into the high-potential group. Manufacturing and transport-related assets perform best, while grade level and accessibility are the strongest predictors of reuse potential. The model provides a scalable evidence base for conservation prioritisation and heritage-led regeneration.
***Keywords*:** industrial heritage buildings; adaptive reuse; data-driven assessment; planning open data; building conservation; redevelopment potential

1. Introduction

Adaptive reuse has become a central strategy in industrial heritage conservation because it can reconcile the material continuity of historic buildings with contemporary urban needs. Yet the practice remains uneven. Many projects still rely on expert appraisal, design narratives, and case-specific feasibility studies, while the criteria used to distinguish viable from fragile reuse candidates are rarely operationalised in a transparent and scalable way [1-2].

Recent scholarship has expanded digital documentation, HBIM modelling, and AI-assisted diagnosis for industrial heritage, but comparatively less attention has been paid to reusable assessment models grounded in openly accessible territorial data. This gap matters because industrial heritage policy increasingly unfolds at portfolio scale rather than at the level of a single building. Planning authorities, conservation agencies, and investors need decision-support tools that can compare buildings across broad geographies while still respecting heritage significance[3-4].This study addresses that gap by constructing a national-scale assessment model for industrial heritage buildings based entirely on public official datasets. The article asks three questions: which industrial heritage typologies dominate the current listed stock; how do accessibility and redevelopment context shape adaptive reuse potential; and which variables most strongly distinguish high-potential from low-potential assets[5-6].

The contribution is methodological and practical. Methodologically, the paper proposes a reproducible scoring framework that combines conservation and redevelopment logics. Practically, it demonstrates how planning open data can be translated into a prioritisation tool for heritage-led regeneration. This positioning aligns with the broader adaptive reuse literature that links conservation, sustainability, and long-term building adaptability.

2. Data and Methods

The analysis combines official listed-building, transport-access-node, brownfield-land, and conservation-area data from the Planning Data environment for England. Together these sources represent heritage significance, accessibility, redevelopment context, and clustering conditions relevant to adaptive reuse.Industrial heritage assets were identified through keyword screening of listed-building names, and only records with valid coordinates were retained. Nearest-neighbour distances to transport nodes, brownfield sites, and conservation-area centroids were then calculated using haversine distance.

A composite reuse index was constructed from five normalized dimensions: grade significance, accessibility, redevelopment context, conservation clustering, and designation age. The weighting scheme prioritizes grade and access while retaining contextual and historical depth.

$$R_i = sum_{(k=1)}^{5} w_k x_{(ik)}, sum_{(k=1)}^{5} w_k = 1$$

High-potential reuse cases were then defined as the upper 30% of the composite-score distribution, and a binomial logistic model was estimated using grade, transport distance, brownfield distance, conservation distance, age proxy, and

typology.The workflow includes dataset collection, industrial screening, distance calculation, indicator normalization, composite scoring, and logistic classification. This sequence creates a reproducible national-scale pipeline for comparing industrial heritage assets.Figure 1 shows that mills, transport, storage, and manufacturing assets dominate the listed stock, which justifies retaining typology as an explicit analytical control.

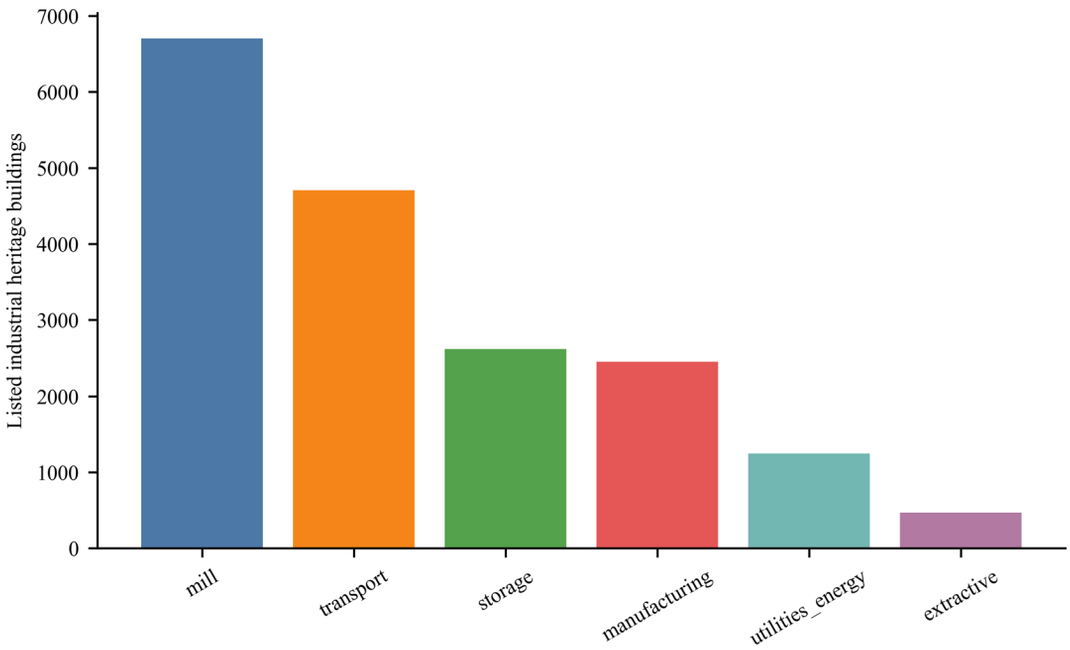

Figure 1. Distribution of industrial heritage typologies

3. Results

The sample contains 18,194 listed assets and is dominated by Grade II buildings. As Table 1 shows, manufacturing and transport-related assets report the highest mean reuse scores and the largest high-potential shares.

Table 1. Typology-level summary statistics

Table 1. Typology-level summary statistics heritage_type	n	mean_reuse_index	share_high	median_transport_km	median_brownfield_km
manufacturing	2452	0.557	0.421	0.110	0.920
transport	4704	0.543	0.398	0.137	0.690
extractive	469	0.520	0.273	0.144	1.640
mill	6701	0.506	0.263	0.222	1.611
storage	2620	0.478	0.196	0.349	1.955
utilities_energy	1248	0.449	0.122	0.412	2.483

Accessibility and redevelopment context vary substantially across the sample. The median distance to the nearest transport node is 0.18 km and the median distance to the nearest brownfield site is 1.38 km, suggesting that many listed industrial buildings already lie within active regeneration geographies.The composite index has a mean of 0.515, and 30.0% of all assets fall into the high-potential class. Manufacturing and transport-related buildings typically combine stronger accessibility with closer redevelopment adjacency than extractive and utilities-energy assets.The logistic results confirm that higher statutory grade and stronger transport accessibility increase the probability of high adaptive reuse potential, while greater distance from brownfield land reduces it. Typology effects remain meaningful after accessibility controls are introduced.

4. Discussion

The findings show that adaptive reuse potential is jointly shaped by heritage protection and urban opportunity. High-

grade assets are not necessarily redevelopment liabilities; when they are accessible and embedded in regenerating contexts, they can become anchor assets for heritage-led transformation. The framework therefore supports differentiated policy strategies across industrial typologies rather than a single conservation template.The study has limitations. Keyword-based identification and centroid distance measures simplify historical and spatial complexity, and the composite weights are theory-informed rather than learned from realized reuse outcomes. Future work should connect the model with project completions, building-level condition data, and stakeholder variables.

5. Conclusion

This article presents a transferable data-driven framework for assessing adaptive reuse potential in industrial heritage buildings using open official data. By combining heritage value with accessibility and redevelopment context, the model offers a practical evidence base for conservation prioritisation and heritage-led regeneration.

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