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An empirical study on the economic factors of the architectural industrial heritage of Hong Kong via the hedonic pricing model

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Abstract

The conservation of historical buildings is essential for safeguarding architectural heritage, facilitating urban development, and promoting sustainable economic growth. This research investigates the adaptive reuse of industrial architectural heritage in Hong Kong, focusing on its sustainable contributions to architectural practice and urban redevelopment. Employing the hedonic pricing model, this study quantitatively analyses the impact of industrial heritage conservation on property prices, revealing its significant contributions to imperatives with economic and developmental goals. Positioning Hong Kong as a paradigmatic example, this study uses a comprehensive analysis of 34,892 property transaction records collected from January 2010 to September 2022 across 23 subdistricts and offers critical insights into the challenges and opportunities of safeguarding industrial heritage within dynamic high-density urban landscapes. The findings indicate that approximately 75% of the variability in industrial property prices can be attributed to significant variables at the 1% confidence level. Key architectural parameters, including gross floor area (GFA), age, and floor level, demonstrate nonlinear relationships with industrial buildings designated for heritage conservation. The data suggest that industrial properties with a GFA of up to 10,989 square feet and an age of up to 41.5 years are considered best for preserving heritage values. Other urban planning parameters, such as the provisions of car parks and proximity to public transportation interchanges, also have significant positive external impacts on industrial property prices. These findings provide empirical evidence regarding the influence of heritage conservation on industrial property prices, serving as a valuable resource for policy-makers aiming to promote sustainable urban development and effective resource allocation. By integrating heritage conservation into urban planning strategies, this research underscores the vital role that preserved industrial heritage can play in fostering vibrant, sustainable urban environments.

Keywords Economic impact, Heritage conservation, Hedonic pricing model, Industrial heritage, Architectural heritage

1 Introduction

The conservation of industrial heritage sites has emerged as a critical concern in contemporary urban societies, given its profound economic, political, cultural, and architectural factors (Han and Li 2023; Qian 2023; Scaffidi 2024). Beyond their historical importance, the conservation of industrial heritage fabric is a strategy for promoting urban (re)development, place making, and new societal engineering (Duan 2023; Graezer Bideau and Bugnon 2024; Guo et al. 2021). As a result,

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safeguarding historic industrial heritage entails not only a cultural imperative but also a developmental necessity to ensure the continuity of the urbanism of the past, present, and future (Carter 2021; Wang and Wang 2018). Adaptive reuse of industrial buildings can minimise waste and reduce the demand for new materials, aligning with the principles of the circular economy in the promotion of sustainability and resource efficiency (Dişli and Ankaralıgil 2023; Foster and Saleh 2021; Gravagnuolo et al. 2024). Revitalising underutilised industrial sites supports sustainable urban development and prevents urban sprawl (Della Spina et al. 2023). The ultimate objective is to effectively manage and reuse existing resources to address reversibility, unobtrusiveness, minimal repair, and respect for the original architectural integrity (Conejos et al. 2019). While the industry heritage literature has focused on concepts such as life cycle analysis, energy consumption reduction, energy efficiency, and embodied carbon neutrality (Foster and Kreinin 2020), a research gap exists within the field of industrial heritage preservation; specifically, a comprehensive methodology that can effectively address the frequently neglected economic aspects for repurposing cultural heritage buildings is needed (Li et al. 2021; Sun et al. 2019). This includes an understanding of built heritage assets, an evaluation of economic sustainability and economic viability, and an analysis of the impact on the real estate market (Cho and Shin 2014; Landorf 2009).

This paper uses the hedonic pricing model to investigate the economic impact of heritage conservation on selected industrial heritage sites in Hong Kong. Choy et al. (2007) applied this model in the context of Hong Kong's real estate market, identifying key pricing determinants. Similarly, this study employs the model for a detailed analysis of how specific architectural features—such as the size of the premises, location, rental prices, and proximity of industrial heritage sites to public transport—impact market value. By isolating these variables, the hedonic pricing model reveals the implicit contributions of individual attributes to overall pricing, thereby enhancing our understanding of the economic significance of industrial heritage sites within urban contexts. With a sample of 34,829 property transaction records for 680 industrial heritage buildings from January 2010 to September 2022, this research identifies both the internal and external attributes of architectural heritage and the physical characteristics of the surrounding urban environments to discuss how these key factors can contribute to the discourse of architectural and urban sustainability.

According to the Sustainable Development Goal (SDG), 11 strives to 'make cities and human settlements inclusive, safe, resilient, and sustainable'. SDG 11.4 explicitly aims to 'strengthen efforts to protect and safeguard the world's cultural and natural heritage' (Lerario 2022). The 2022 UNESCO Institute for Statistics (UIS) survey revealed a steady increase in per capita expenditure on the conservation of cultural and natural heritage worldwide, indicating a growing global commitment to preserving architectural heritage (Carreira, González-Rodríguez, and Díaz-Fernández 2022). However, the heritage-related research literature has faced criticism for its Western-centric focus (Aygen 2013; Lerario 2022; Martins 2016). Hong Kong was selected as the study location for two reasons. First, it offers a fresh insight into studies on the relationship between heritage conservation and urban economics in a high-density Asian context. While there are papers examining the industrial heritage of Hong Kong (Leung and Soyez 2009; Ng 2022; Yang et al. 2023), most of them focus on cultural significance, and few focus on the economic factors affecting heritage revitalisation. Second, Hong Kong has a legacy of being a prime industrial manufacturing hub in the post-World War II period, but little research has been conducted on its rich built heritage context (Lee et al. 2018; Leung and Soyez 2009). The paper is organised into several sections. First, the literature review includes an exploration of various relevant literature on mainstream heritage practices and background. Second, the next section provides an overview of adaptive reuse of the architectural alteration of a typical industrial heritage. Third, the methodology section introduces the hedonic pricing model, its applications, advantages, limitations, and regression results. Finally, the conclusion section summarises the research findings and offers analysis and recommendations by capturing the diverse ways in which architectural preservation impacts property values and the broader community by transforming these sites as catalysts for urban regeneration (Sun et al. 2019; Vukmirović and Nikolić 2023).

2 Literature review and background

2.1 Industrial heritage literature review

The notion of industrial heritage conservation emerged in the 1970s in Europe, emphasising the importance of preserving and repurposing historical industrial buildings to maintain their unique heritage value. By integrating industrial heritage conservation with adaptive reuse, new opportunities arise for promoting sustainable practices that not only safeguard future resources but also foster sustainability criteria (Gonçalves et al. 2022). Research on industrial heritage revitalisation encompasses structural assessments (Corredor-Ochoa et al. 2020; Kuban and Pretelli 2021; Zhang and Dong 2021), authentic interventions in adaptive reuse practices (Samadzadehyazdi et al. 2020), and contemporary construction technologies (Eberhardt and Pospisil 2022; Iglesias and Bernardo 2022). Other recent studies have shifted their focus towards the industrial heritage economy (Lak et al. 2020), the circular economy framework (Andrade et al. 2024; Della Spina et al. 2023; Dişli and Ankaralıgil 2023), and industrial heritage-driven urban regeneration (Arbab and Alborzi 2021; Chen 2022). However, research on economic and developmental imperatives and driving forces underpinning industrial heritage conservation within the urban context remains limited (Li et al. 2021; Sun et al. 2019). With an emerging body of literature advocating adaptive reuse of industrial heritage (Babutsalı Alpler, Şahin, and Dağlı 2020), the benefits from transforming industrial heritage become the 'pretext' for continuation of a city's architectural history (Iglesias and Bernardo 2022) while integrating with its rich urban fabric (Barillari and Stival 2022). The application of the hedonic pricing model (Rosen 1974) in this study provides a quantitative approach to assess the economic value and spillover effects associated with industrial heritage assets from the perspective of local property markets in analysing property characteristics such as rental rates, proximity to industrial heritage sites, and other urban parameters such as district and proximity to public transport hubs.

Converting industrial sites with historical significance, such as factories and warehouses, into cultural and community megainfrastructural landmarks, such as museums, galleries, and Olympic sites, creates new opportunities for social engineering and empowers direct economic growth (Graezer Bideau 2018; Jones and Zhang 2024; Zhang 2024). However, the urban regeneration of industrial heritage also faces criticism for overprioritising market-driven objectives over community-oriented outcomes. For example, regeneration efforts in Leeds have highlighted tensions between preserving industrial heritage and addressing the social needs of existing communities, leading to exclusivity, loss of the historical sense of place, and gentrification (Citron 2021; Cizler 2012). To alleviate potential gentrification resulting from industrial revitalisation projects, more community participation, public engagement, and public–private partnerships can create a more inclusive approach to the reuse of industrial sites. For example, community-based organisations (CBOs) can play a vital role in decision-making to encourage greater local community involvement in the redevelopment process (Oevermann et al. 2016). Other studies have identified a range of thematic groups to establish multiple criteria for positioning industrial heritage in the sustainable assessment landscape in terms of environmental, architectural, economic and urban-related analysis criteria (Table 1) (Pardo Abad 2020). Industrial heritage revitalisation contributes as an indicator of economic sustainability (Dişli and Ankaralıgil 2023), such as job creation (Grazuleviciute-Vileniske 2006; Navrud and Ready 2002), urban events (Szromek et al. 2021), and urban revitalisation (Zavadskas and Antucheviciene 2006). Repurposing old industrial complexes to new cultural sites can boost new employment, increase property value, and attract new businesses (Altrock and Ma 2014; Loures and Panagopoulos 2007, 2010). Regarding environmental sustainability, Gonçalves et al. (2022) used the International Organisation for Standardisation criteria in analysing building sustainability assessment (BSA). One factor in supporting environmental sustainability is extending heritage buildings' life cycles to reduce carbon emissions and developing a circular economy by reusing, recycling, or repurposing architectural elements (Della Spina et al. 2023; Dişli and Ankaralıgil 2023; Luken and Castellanos-Silveria 2011). This results in major construction cost

Table 1 Groups and main analysis criteria for the valuation of industrial heritage in terms of sustainability (Pardo Abad 2020)

Thematic Groups	Main Analysis Criteria
Territorial and landscape sustainability **(TlS)**	**TlS1** Comprehensive planning of the territory
	TlS2 Improvement of territorial and urban elements
	TlS3 Adaptation of natural and built spaces
	TlS4 Improvement of the scenic quality of the postindustrial landscape
Environmental sustainability **(EnS)**	**EnS1** Comprehensive recovery of the environment
	EnS2 Environmental restauration
Architectural sustainability **(ArS)**	**ArS1** Efficient recovery of the original architecture
	ArS2 Adaptation of new uses to buildings
	ArS3 Rational use of new materials and structures
Tourism and economic sustainability **(TeS)**	**TeS1** Promotion of tourism as an instrument of sustainable revaluation
	TeS2 Digital dissemination of content
	TeS3 Search for efficient and sustainable management models
	TeS4 Generation of local employment and new tertiary activities

savings, improved energy efficiency, and reduced carbon footprints in adaptive reuse processes (Han and Zhang 2022; Lidelöw et al. 2019; Munarim and Ghisi 2016).

Through adaptive reuse, historical industrial structures are transformed into novel amenities, thereby showcasing patrimonial assets with sustainable initiatives (Arbab and Alborzi 2021; Bullen and Love 2011; Yung and Chan 2012). Xie et al. (2020) illustrated how a place-based urban redevelopment of industrial heritage inspired creative businesses, fostered economic growth, and cultivated vibrant and sustainable communities, emphasising the roles of urban planning and architectural design in enhancing the economic profitability of industrial properties (Arbab and Alborzi 2021; Guo et al. 2021; Iglesias and Bernardo 2022; Ryberg-Webster and Kinahan 2013).

2.2 Heritage conservation and economic externality

While some studies have highlighted the role of industrial heritage conservation in enhancing quality of life and improving governance strategies within the framework of sustainable urbanism (Corredor-Ochoa et al. 2020; Xian and Chen 2015), other research presents mixed findings. For example, Van Duijn, Rouwendal, and Boersema (2016) explored the impact of redeveloping industrial heritage sites on surrounding house prices in the Netherlands. Their findings indicated that the negative effects associated with redevelopment typically lessen once projects begin, whereas positive outcomes tend to arise after completion. Such economic benefits in terms of housing prices often diminish in larger urban environments. This body of literature contributes to our understanding of the economic effects of industrial heritage sites, yet significant research gaps remain. Therefore, further research is essential for fully exploring the intricate relationship between industrial heritage and economic impact, as much of the literature is still inconclusive (Van Duijn, Rouwendal, and Boersema 2016).

2.3 Hong Kong industrial heritage and its socio-political context

As the most urbanised city in Asia, Hong Kong has served as a prominent international industrial port since the Hong Kong Island was ceded to Britain in 1842. The city's industrial legacies from the 1950s to the 1990s contributed significantly to its distinctive urban fabric and global legacy, reflecting a blend of colonial influences with Western and Chinese elements (Chan and Lee 2008). This period of economic prosperity led to the emergence of extensive distinctive industrial districts and architecture (Shelton et al. 2013) (Fig. 1).

The selection of Hong Kong for the study of industrial heritage is predicated on its distinctive historical and geopolitical context as an international industrial landmark, which renders it both an exceptional and illustrative exemplar for scholarly analysis. Hong Kong's colonial legacy, and the reputation of a global export and trading port since World War II, has engendered a unique industrial and cultural context (Fok 2024), with a condensed narrative of industrialisation to broader global economic shifts (Xian and Chen 2015). This microcosmic representation of industrial history, encapsulated within Hong Kong's limited geographic confines, offers an unprecedented case study for examining socioeconomic transformations (Zhang et al. 2023). In response to preserving industrial heritage, the Hong Kong SAR Government launched the Industrial Building Revitalisation Scheme in 2018 to facilitate the conversion of existing industrial buildings aged fifteen years or above for specific uses prescribed by the government, including cultural and creative industries (Legislative Council Panel on Development 2021). However, some criticisms have been raised regarding the government's laissez-faire approach to industrial space revitalisation (Xian and Chen 2015) and limited research on industrial heritage revitalisation (Chan, Zhai, and Cheung 2012; Stratton 2003; Tang and Ho 2014; Tang and Tang 1999) and how adaptive reuse can be an economic catalyst for urban regeneration (Zhang and Dong 2021).

3 Research objective and hypothesis

Since research findings on real estate prices in relation to industrial heritage contexts in Hong Kong remain inconclusive (Rudokas et al. 2019), this study explores the pricing patterns of industrial buildings by examining the effects of various architectural and urban parameters. Specifically, it investigates two primary categories of factors: architectural parameters of industrial buildings (floor level, structure, area, and age of the property) and urban planning factors (proximity to transport infrastructure and district characteristics at different locations). The research hypothesises that positive correlations exist between the identified factors and property market prices, and it also hypothesises a negative correlation between the floor level and rental prices.

4 Data and methodology

This section explains the fluctuations in industrial property prices on the basis of a dataset of 34,892 transaction records from 680 heritage properties collected between

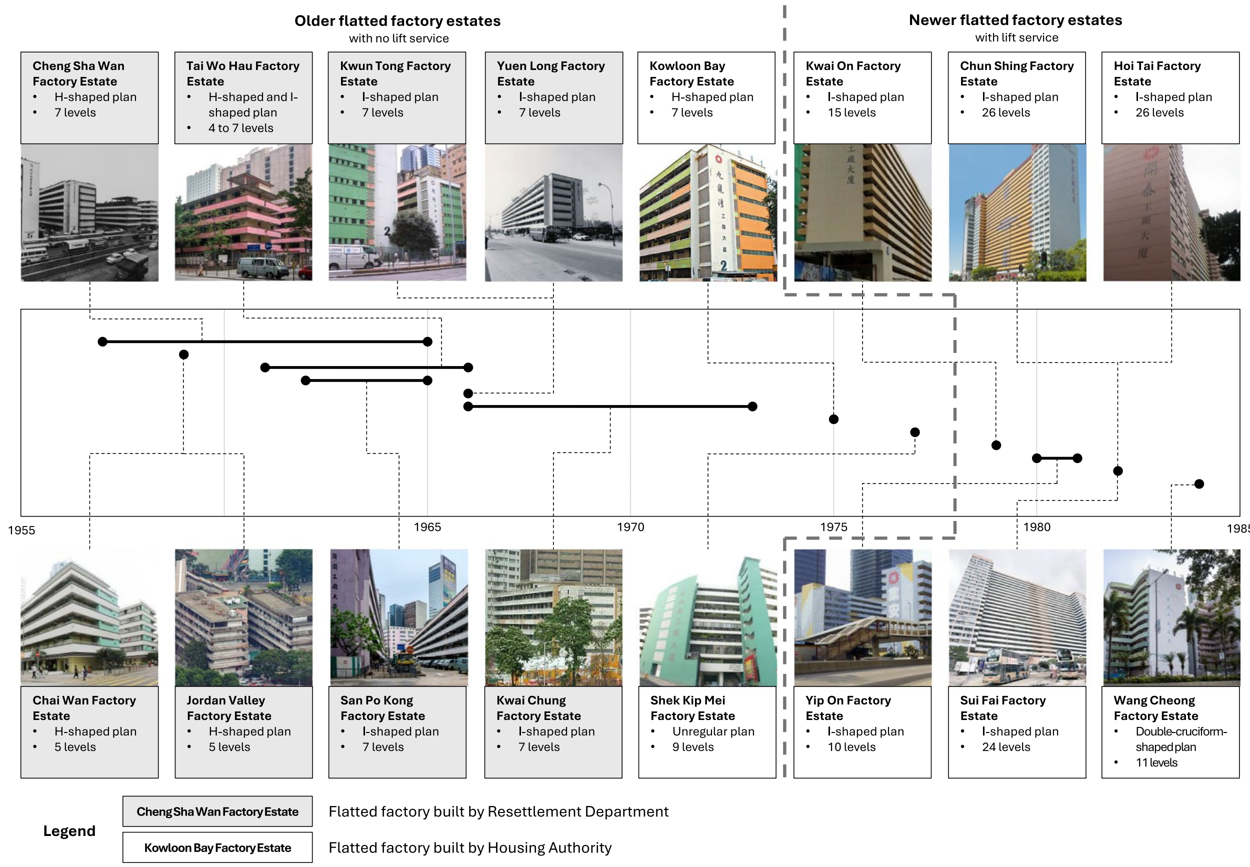

Fig. 1 Examples of representative Hong Kong's industrial buildings and their years of construction (Source: summarised by the author, photo provided by the Information Services Department Photographic Library, Create Hong Kong, Timeless Estates HK, Centmap Company Limited and Survey & Mapping Office, Hong Kong Public Libraries, Hong Kong Place, Wenweipo, Hong Kong Housing Authority, Oriental Daily and HK01 Company Limited)

January 2010 and September 2022 across 23 selected sub-districts. A statistical model is developed using ordinary least squares (OLS), which assumes that the regression coefficients and the variances of the residuals remain constant across observations (Rosen 1974).

4.1 Hedonic pricing model

The hedonic pricing model is a methodology that is used for urban analysis, offering insights into the valuation of urban attributes. This model decomposes the price of a marketed good into the value of its constituent characteristics, making it particularly useful for assessing the influence of various urban factors, such as location, accessibility, and environmental quality, on real estate prices (Rosen 1974). The applicability of the hedonic pricing model in urban studies allows for more detailed and spatially explicit analyses (Anselin 2013; Bivand et al. 2008), capturing the nuanced effects of urban amenities on housing prices (Cheshire and Sheppard 2017; Gibbons and Machin 2008). Despite its strengths, the model has its limitations, including issues with multicollinearity and omitted variable bias, which necessitate more robust econometric techniques (Malpezzi 2003). However, the hedonic pricing model remains a valuable tool for urban analysts, providing critical insights for understanding the factors influencing property values (Dziauddin 2021; Liebelt et al. 2019; Lisi and Iacobini 2020; Noor, Asmawi, and Abdullah 2015; Reichel and Zimčík 2018; Sharmin 2020; Sylla et al. 2019; Yang et al. 2023).

By employing the hedonic model that regresses property prices on our chosen variables (Cerin et al. 2014), it is possible to estimate the intrinsic values that directly affect the market prices of these industrial buildings. To estimate the nonlinear effects associated with certain housing attributes, a linear specification is chosen as follows:

$$RP = \alpha + \beta_1(GFA) + \beta_2\left(GFA^2\right) + \beta_3(AGE) + \beta_4\left(AGE^2\right) + \beta_5(FL) + \beta_6\left(FL^2\right) + \beta_7(CP) + \beta_8(CA) + \beta_9(MTR) + \beta_{10}\left(MTR^2\right) + \beta_{11...32}(DISTRICT) + \varepsilon \quad (1)$$

where *RP* represents the transaction price of industrial buildings measured in HK$ million, which is deflated by the official industrial property price index published by the Rating and Valuation Department (HKSAR); *GFA* represents the gross floor area measured in square feet; *AGE* represents the property age at the time of the transaction, which can be measured by the difference between the date of the issue of the occupation permit and the date of the transaction; *FLOOR* represents the floor level of an industrial property; *CP* represents the number of carparks sold with an industrial property; *CA* is assigned a value of 1 if the common area associated with an industrial property that is managed by its owner, 0 otherwise; *MTR* is the distance of the property to the nearest mass transit railway (MTR) public transport station measured in metres; and *DISTRICT* is a dummy variable that is assigned a value of 1 if an industrial building is located in a specific district, 0 otherwise. Since our dataset comes from 23 subdistricts, 22 dummies are used to avoid singularity. The omitted category is *HKI-CW,* so the coefficients may be interpreted relative to this category. In addition, the quadratic forms of *GFA*, *AGE*, *FLOOR* and *MTR* are incorporated to discern the nonlinear effect of structural characteristics; ε is an idiosyncratic error term; and $\beta_{1...32}$ represents the parameters to be estimated.

The research hypothesis proposes that industrial property prices are influenced by key architectural factors, including GFA, age, floor level, distance to a mass transit railway station, number of carparks, and the need to manage a common area. Specifically, it is anticipated that industrial properties with a larger GFA will have higher prices, all else being equal. This is because a larger GFA provides more space for occupiers to conduct business, which can be a valuable amenity for many industrial users. It is hypothesised that 1) older industrial properties may have lower prices due to depreciation, wear and tear, and potential maintenance concerns and that 2) higher floor levels may be associated with higher costs for the installation of elevators, building maintenance, and accessibility, which could offset any potential benefits of increased visibility. In contrast, properties located closer to public transportation stations are expected to have higher prices because of their increased attractiveness to tenants and investors. The presence of carparks is anticipated to lead to a premium price being charged, as these provide an added amenity for tenants and increases a property's value and desirability. On the other hand, properties requiring shared spaces or shared responsibilities may be less desirable or more costly to manage, resulting in lower prices.

To examine the potential presence of heteroskedasticity, this study refers to White's test (White 1980), a statistical procedure that tests the null hypothesis of no heteroskedasticity against the alternative hypothesis of heteroskedasticity of some unspecified form. While ordinary least squares (OLS) estimation provides consistent parameter estimates even in the presence of heteroskedasticity, its standard errors are biased because of the failure to account for heteroskedasticity. The White test statistic is calculated through an auxiliary regression, wherein the squared residuals are regressed on all possible (nonredundant) cross-products of the regressors. Specifically, the following equation is estimated:

$$y_t = b_1 + b_2x_t + b_3z_t + e_t \quad (2)$$

where b_i are the estimated parameters and where e_t is the residual term. The test statistic is then based on the following auxiliary regression:

$$e_t^2 = \delta_0 + \delta_1x_t + \delta_2z_t + \delta_3x_t^2 + \delta_4z_t^2 + \delta_5x_tz_t + v_t \quad (3)$$

The Obs*R–squared statistic is White's test statistic, which is calculated as the product of observations and the centred R^2 derived from the test regression. Although the finite-sample distribution of the *F* statistic under the null hypothesis remains unknown, White's test statistic converges asymptotically to a chi-square distribution with degrees of freedom corresponding to the number of slope coefficients (excluding the intercept term) in the test regression. This approach can be regarded as a general test for model misspecification, given that the null hypothesis posits that the errors are homoscedastic and independent of the regressors and that the linear specification of the model is valid.

The violation of any one of these conditions can result in a statistically significant test statistic. In contrast, a nonsignificant test statistic suggests that none of these conditions have been breached. If heteroskedasticity is detected in the model, the White Heteroskedasticity Consistent Covariances (HAC) method is used to calculate consistent covariance estimates. While the point estimates remain unchanged, the estimated standard errors are robust.

4.2 Data and descriptive statistics

Our original dataset comprises a comprehensive sample of 43,530 transaction records from 822 industrial buildings across 23 subdistricts in Hong Kong, spanning the period from January 2010 to September 2022. However, upon examination, more than 2,000 property transactions were sold by resale, and numerous missing values were identified in variables such as the *GFA*. These data were subsequently excluded from the analysis. This resulted in a reduced sample of 38,699 observations from 777 industrial buildings. To mitigate the influence of outliers and potential errors, we delete the 5% of observations with the lowest and highest transaction prices, thereby refining our dataset. Our final analysis included 34,829 cross-sectional intertemporal observations from 680 industrial buildings across 23 subdistricts.

Table 2 presents a concise summary of the descriptive statistics for our dataset. The dependent variable is the transacted property price, adjusted for inflation. The mean transaction price is approximately HK$0.7 million, with a standard deviation of HK$0.46 million (65.2% of the mean). The mean gross floor area is 3,262.2 square feet, with a standard deviation of 2,021.0 square feet (62% of the mean). The average age of the transacted units is 27.2 years, with a standard deviation of 8.9 years (32.8% of the mean). Furthermore, the mean floor level is 10.3 floors, with a standard deviation of 6.2 floors (60.6% of the mean). Additionally, the mean proximity to the MTR station is 539.3 m, with a standard deviation of 240.5 m (44.6% of the mean).

5 Results

Table 3 presents the estimated coefficients, z statistics, goodness-of-fit measures, and diagnostic statistics for the Hong Kong model. The majority of the variables exhibit statistically significant results at conventional levels, and they display the expected signs. Notably, heteroskedasticity is prevalent across all four models, as evidenced by the statistical significance of the Lagrange multiplier (LM) statistic, which suggests that the standard errors are not robust. LM statistics and their p values are estimated to be 8,908.80 and 0.0 for our full sample, 516.29 and 0.0 for Hong Kong Island, 5,895.44 and 0.0 for Kowloon, and 2,702.62 and 0.0 for the New Territories, respectively. To address this issue, we employ HAC methods to obtain reliable and robust standard errors in all the models. Instead of relying on t statistics to determine the significance of our explanatory variables, we utilise z statistics to evaluate their importance.

Our comprehensive analysis of the dataset reveals that a substantial proportion of the variables are statistically significant at the 1% confidence level, conforming to theoretical expectations. The model's explanatory power is impressive, accounting for approximately 75% of the variability in industrial property prices. A closer examination of the findings indicates that apartment size, age, floor level, and distance to mass transit railway stations all exhibit nonlinear relationships with industrial property prices.

Specifically, our linear regression model suggests that an increase in *GFA* up to 10,989 square feet is positively correlated with property prices. This optimal threshold can be obtained by calculating $-0.0004/(2 * -0.0000000182)$. However, beyond this threshold, the *GFA* is negatively correlated with prices. This finding implies that, up to a certain point, larger industrial properties tend to command higher prices because of their increased capacity and potential for higher rental income or productivity. Nevertheless, beyond this threshold, the additional benefits of larger properties may be offset by diminishing returns or other factors, leading to a decrease in property values.

Similarly, our analysis reveals that age has a nonlinear relationship with property prices. Specifically, prices decrease as age increases to 41.5 years before increasing thereafter. This optimal threshold can be obtained by calculating $-(-0.0166)/(2 * 0.0002)$. This pattern may be attributed to the existence of an optimal age range for industrial properties, where properties that are too old may require significant renovations or maintenance, whereas those that are too new may lack the character or history that some industrial tenants value. Beyond this optimal range, however, older properties may regain value because of their established reputation or proven track record.

Table 2 Descriptive statistics of model variables

	Mean	Min	Max	Stdev	Skew
Deflated Transaction price **RP** (in HK$ million)	0.702	0.225	2.544	0.458	1.682
Gross floor area G**FA** (in ft^2)	3262.209	250	14,671.430	2021.021	1.285
AGE (in year)	27.160	0.008	60.189	8.906	-0.393
Floor level **FL**	10.297	-1	42	6.240	0.812
No. of carparks **CP**	0.009	0	9	0.112	24.904
Availability of common area (1 or 0)	0.006	0	1	0.0754	13.116
Distance to the nearest MTR station **MTR** (in m)	539.341	100	1200	240.450	0.100

Table 3 Regression results

	Full Sample	HKI	KL	NT
Intercept	0.6708[a]	0.4446[a]	0.5861[a]	0.6587[a]
GFA	0.0004[a]	0.0006[a]	0.0006[a]	0.0004[a]
GFA^2	-1.82E-08[a]	-1.906e-08[a]	-3.361e-08[a]	-1.56E-08[a]
AGE	-0.0166[a]	-0.0201[a]	-0.0138[a]	-0.0186[a]
AGE^2	0.0002[a]	0.0002[b]	2.883e-05	0.0002[a]
Floor	-0.0029[a]	0.0044[a]	-0.0032[a]	-0.0037[a]
$Floor^2$	0.0001[a]	-0.0001[b]	8.906e-05[a]	0.0002[a]
CP	0.0956[a]	0.3162[a]	0.0898	0.1141[a]
CA	-0.1387[a]	0.0613	-0.1535[a]	-0.0915
MTR	-0.0002[a]	0.0008[a]	-8.274e-05[a]	-0.0007[a]
MTR^2	1.17E-08	-9.591e-07[a]	-1.458e-07[a]	4.16E-07[a]
HK-ABD	0.2611[a]			
HK-KNDT	0.3917[a]			
HK-NP	0.6248[a]			
HK-SYP	0.423[a]			
HK-WCH	0.175[a]			
KL-CSW	0.1134[a]			
KL-HH	0.4385[a]			
KL-KLB	0.0224[a]			
KL-TKW	0.3259[a]			
KL-KT	0.0967[a]			
KL-YT	-0.0898[a]			
KL-MK	0.1912[a]			
KL-SPK	-0.0222[a]			
KL-TKT	-0.099[a]			
NT-FL	-0.2563[a]			
NT-KC	-0.2569[a]			
NT-SS	-0.1032[a]			
NT-ST	-0.1205[a]			
NT-TM	-0.3602[a]			
NT-TW	-0.1963[a]			
NT-TY	-0.282[a]			
NT-YL	-0.1494[a]			
GFA Threshold	10,989.0	15,739.8	8,925.9	12,820.5
AGE Threshold	41.50	50.3	239.3	46.5
FLOOR Threshold	14.5	22	18.0	9.3
MTR Threshold	8,547.0	417.1	-283.7	841.3
R^2	0.750	0.678	0.713	0.735
Adjusted R^2	0.750	0.676	0.713	0.735
F-Statistic	636.5	298.7	205.5	839.3
Log-Likelihood	1939.3	0.00	-887.11	4313.0
N	34,829	2,340	11,399	21,090

[a] represents statistically significant at 1% confidence level

[b] represents statistically significant at 10% confidence level

Furthermore, the floor level exhibits a similar nonlinear pattern, with prices decreasing to 14.5 levels and increasing beyond this threshold. This optimal threshold can be obtained by calculating $-(-0.0029)/(2*0.0001)$. This finding suggests that there may be an optimal floor level range for industrial properties, where lower floors offer better accessibility and visibility, whereas higher floors provide more desirable views or prestige. Properties above this optimal range may command higher prices because of their perceived prestige or unique attributes.

These nonlinear relationships highlight the complexity of the industrial property market and the need for nuanced modelling approaches that can capture these subtle interactions. The results have important implications for developers, investors, and policy-makers seeking to understand the drivers of industrial property values and make informed decisions about investments and urban planning strategies.

Notably, our analysis reveals a negative association between floor level and industrial property prices, which can be attributed to the reduced time and effort required for loading and unloading products and machinery from container trucks at lower-floor properties compared with those at higher floors. This finding highlights the importance of logistical considerations in the industrial property market, where accessibility and efficiency can significantly impact property values.

Other results indeed reveal that proximity to MTR stations is a highly valued feature among industrial property buyers, as it facilitates easier transport and connectivity. The proximity of MTR stations contributes to a more efficient and environmentally friendly industrial landscape by reducing the need for personal vehicles and promoting alternative modes of transport. The nonlinear effect of distance to MTR stations on property prices suggests that properties within a certain range (up to 8,547 m) are not favoured by buyers because of their distant public transport. This optimal threshold can be obtained by calculating $-(-0.0002)/(2*0.0000000117)$. In this study, the maximum distance to the MTR is approximately 1,200 m, which means that all the industrial properties fall within this threshold distance (Radzi 2018; Whitehead 2011).

The presence of a car park associated with the sale of an industrial property is also found to have a significant effect on property values, with an estimated premium of HK$95,600 in real terms. This phenomenon can be attributed to the fact that accessible car parking is a critical consideration for businesses that rely on the transport of goods and services. Industrial properties that provide sufficient parking space allow for easier logistics and operational efficiency, making them more attractive to prospective buyers or tenants. As businesses prioritise convenience and accessibility for their employees, clients,

Table 4 Proposed thematic groups and recommendations on industrial heritage

Thematic Groups	Recommendations
Architectural Sustainability **(ArS R)**	**ArS R1** Essential maintenance of the unique industrial characteristic, such as the orthogonal layout of the flatted factories and intricate external brickworks
	ArS R2 Adaptive use of industrial heritage that can bring diversity in business operations
	ArS R3 Reuse of building structures that can save costs in construction and building materials sourcing
Urban Sustainability **(UrS R)**	**UrS R1** Leverage of proximity of industrial buildings to transportation infrastructure to achieve environmental sustainability
	UrS R2 Adaptive reuse that can initiate urban renewal in districts with special industrial histories
	UrS R3 Recognition that urban sustainability is dependent on all three pillars of sustainable development in which economic impact is a vital element that requires support from other interconnected factors

and delivery services, the availability of parking becomes a crucial aspect in evaluating industrial property.

On the other hand, our analysis reveals that the requirement to manage a common area shared with other owners and tenants reduces property values by HK$138,700 in real terms. This finding highlights the importance of considering the communal aspects of industrial properties, where shared spaces can create both benefits (e.g., community building) and drawbacks (e.g., management responsibilities). The presence of shared areas can affect the overall value proposition of an industrial property, making it essential for developers and investors to carefully weigh these factors when evaluating potential projects.

These findings provide valuable insights into the complex interplay of factors influencing industrial property values in Hong Kong. By considering these nuanced relationships between physical attributes, amenities, and logistical considerations, developers and investors can better understand the needs and preferences of industrial property buyers and make informed decisions about investments in this sector.

The results of the analysis for Hong Kong Island, Kowloon, and the New Territories are found to be remarkably consistent with the overall sample. The statistical significance of the variables is maintained at the 1% confidence level, indicating robust findings. Furthermore, the threshold levels of the variables *GFA*, *AGE*, *FLOOR*, and *MTR* are also presented in Table 3.

Notably, the threshold distance to the MTR station in the Kowloon model is -284 m. This optimal threshold is obtained by calculating $-(-0.00008274)/(2 * -0.0000001458)$. This value is physically implausible, as distance cannot be negative. This anomalous finding suggests that industrial property buyers in Kowloon are willing to pay a premium for properties with convenient locations, even if they are farther away from MTR stations than would be expected. This could be attributed to the unique characteristics of Kowloon's industrial landscape, where proximity to major transport hubs may be particularly valued by businesses operating in the area. This finding highlights the importance of considering local market nuances and nuances when developing predictive models for industrial property prices.

6 Significance and conclusion

This paper examines how industrial heritage conservation is integral to achieving sustainability in a high-density urban context, such as Hong Kong. The conservation of intangible heritage values and recognition of the economic benefits of industrial heritage serve to strike a balance between economic, environmental, social, cultural, and architectural sustainability. To preserve the historical richness of a city, it is crucial to appreciate its architectural and urban heritage values and implement appropriate conservation mechanisms. The empirical analysis reveals some apparent contradiction to the traditional correlation between the floor level of an industrial property and property prices. Empirical evidence shows that the variable floor level is inversely related to property prices in the context of industrial buildings. This phenomenon suggests that higher-level floors are deemed less desirable due to inconvenient access and lower passenger flow, reducing the likelihood of customers reaching the industrial establishment with direct access. The empirical findings provide evidence to support the impact of industrial heritage conservation on urban morphology. The results underscore the importance of recognising different aspects of sustainability with specific architectural and urban attributes in the analysis criteria and recommend further heritage research to strategise urban planning and policy development in the future.

This research distinguishes itself from similar studies by providing insights in a high-density urban context. The findings highlight the importance of industrial heritage conservation on the agenda of SDGs 11 and 12 in making cities more resilient and sustainable by conserving the city's valuable assets (Table 4).

Although this paper acknowledges the economic aspects of industrial heritage conservation in Hong Kong, the multifaceted process of industrial heritage revitalisation involves multiple considerations to attain the ultimate sustainability outcomes. With respect to the literature framework of urban sustainability and the SDGs, this paper also has some limitations and challenges related to industrial heritage preservation. To overcome these limitations, research and collaboration should be emphasised across disciplines, involving architects, urban planners, historians, and community stakeholders, to develop a comprehensive understanding of living heritage, architectural significance, and adaptive reuse of industrial heritage. Policy-makers and stakeholders should recognise the value of industrial heritage and prioritise conservation during future urban planning and decision-making processes.

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Authors' contributions
TK completed conceptualisation, methodology, survey design and distribution, formal analysis, writing original draft, and review and editing. KC completed review and editing. All authors read and approved the final manuscript.

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The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

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The authors declare that they have no competing interests.

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