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Creative Ecosystems and Urban Sustainability: Evidence from Global Cities

Mavera Mukhtar[1*], Mohamed Merza Khalil Ebrahim Al.Rayes[2]

[1] Department of Life Sciences, University of Management and Technology Pakistan, Lahore, Pakistan;
[2] Physiotherapy, College of Health Sciences, University of Bahrain, Ahlia University, Manama, Bahrain;

* **Corresponding author:** mavera0786@gmail.com.

ABSTRACT: Cultural and creative activity is often presented as a source of urban vitality, yet comparative evidence typically combines cultural amenities, entrepreneurship, social openness, and sustainability without clarifying how these components work together. This study develops and tests a city-level creative-ecosystem framework across a primary sample of 82 global cities. We standardized cultural amenities, creative entrepreneurship, and enabling conditions and integrated them into a Creative-Ecosystem Capacity Index, while evaluating sustainable urban performance through people, planet, profit, and overall city outcomes. We used Spearman correlations, heteroskedasticity-robust regression, quartile comparisons, principal-component sensitivity analysis, and cluster analysis, followed by independent validation against climate-governance and urban-prosperity indicators. The integrated index was positively associated with overall sustainable-city performance (B = 6.14, p = .036) and showed its strongest adjusted relationship with the profit dimension (B = 11.48, p = .009). Enabling conditions, represented by education, digital access, and tolerance, were more consistently associated with overall and people-centered outcomes than cultural amenities alone. Cities in the highest creative-ecosystem quartile recorded a mean overall score of 72.10 compared with 30.00 in the lowest quartile. External validation produced positive correlations with sustainability governance (rho = .487) and city prosperity (rho = .829). The findings indicate that cultural provision becomes more consequential when embedded in entrepreneurial, educational, digital, and inclusive urban systems. Because the design is cross-sectional and relies on harmonized public indicators, the results establish comparative associations rather than causal effects. The study contributes a measurable, policy-oriented framework for evaluating culture-led urban development without reducing creative capacity to venue counts or cultural visibility alone.

Keywords: cultural amenities; creative ecosystems; sustainable urban development; creative entrepreneurship; urban governance; global cities.

I. INTRODUCTION

Cities increasingly seek development models that combine economic vitality with liveability, social inclusion, cultural identity, and environmental responsibility. Cultural and creative activities have become central to this agenda because they operate simultaneously as economic assets, sources of symbolic value, urban amenities, platforms for entrepreneurship, and mechanisms of place formation. Cultural districts, heritage sites, festivals, design networks, performing-arts venues, creative workspaces, and digital cultural production are therefore widely incorporated into urban-development strategies. However, culture's broad scope creates an important analytical challenge: visible cultural provision does not necessarily mean a city has the institutional, entrepreneurial, and social conditions to convert creative resources into sustainable urban outcomes.

A city may have prominent museums, theatres, festivals, or heritage assets while still experiencing weak participation, limited business development, unequal access, or inadequate institutional support. Cultural visibility alone cannot therefore explain differences in urban sustainability. Culture's developmental

significance depends on the wider ecosystem in which it is embedded, including education, digital connectivity, tolerance, entrepreneurship, finance, governance, and access to opportunity. These conditions shape whether cultural resources remain isolated attractions or become integrated components of inclusive urban development.

Comparative evaluation is further complicated by the diversity of creative industries and urban contexts. Creative activities vary in their dependence on labor markets, knowledge networks, consumers, infrastructure, and public institutions. Their contribution may also differ across economic, social, and environmental dimensions. Measures based only on venue numbers, cultural employment, tourism, or creative-business density may therefore capture one aspect of urban creativity while overlooking the conditions that enable cultural activity to generate wider benefits. Composite city rankings offer useful comparisons, but they may obscure the mechanisms behind strong or weak performance.

This study addresses these limitations by conceptualizing creative capacity as an urban ecosystem with three complementary dimensions. Cultural amenities represent access to leisure, cultural experience, and place-based attraction. Creative entrepreneurship reflects start-up activity, venture finance, and business conditions that enable creative ideas to develop into organizations, products, and services. Enabling conditions include education, digital access, and tolerance, which support participation, knowledge exchange, innovation, and attracting and retaining diverse talent. These dimensions are combined in a Creative-Ecosystem Capacity Index and examined in relation to people, planet, profit, and overall sustainable urban performance.

The study does not assume that cultural amenities directly produce sustainability. Instead, it investigates whether cities with stronger, more balanced creative ecosystems tend to achieve more favorable sustainable-development outcomes. It also examines whether the observed relationships differ across social, environmental, and economic dimensions. Because the research uses a cross-sectional comparative design, the findings are interpreted as associations rather than causal effects. Robust estimation, sensitivity testing, cluster analysis, and independent validation are applied to strengthen the reliability of the evidence.

The primary analysis includes 82 matched global cities. We use two additional samples for external validation: 105 cities with climate-governance indicators and 42 cities with multidimensional urban-prosperity measures. This structure allows the main relationships to be examined across alternative definitions of urban performance without substantially reducing the size of the primary sample.

The study aims to determine whether cultural amenities, creative entrepreneurship, and enabling urban conditions are associated with sustainable urban performance and to identify which combination of factors provides the most consistent explanation of city-level differences. It constructs a transparent creative-ecosystem index, compares the integrated index with its individual dimensions, examines differences across people, planet, profit, and overall outcomes, identifies distinct urban profiles, and evaluates whether the main findings remain stable under alternative governance and prosperity measures.

The analysis addresses five related questions: how strongly the three creative-ecosystem dimensions are associated with sustainable urban performance; whether the integrated index provides a stronger explanation than its separate components; whether the relationships are more pronounced for economic, social, or environmental outcomes; whether cities form interpretable groups according to their creative and sustainability profiles; and whether the observed patterns are reproduced in independent validation samples.

The study contributes theoretically by connecting creative-city, cultural-sustainability, and urban-ecosystem perspectives within a unified capability framework. Methodologically, it combines rank-sensitive correlation, heteroskedasticity-robust regression, principal-component sensitivity analysis, quartile comparison, cluster profiling, and external validation rather than relying on a single indicator or city ranking. Practically, it offers a diagnostic framework that enables urban policymakers to distinguish between cities that are culturally visible, entrepreneurially dynamic, institutionally supportive, or balanced across all three dimensions. In this way, culture-led development is evaluated as a coordinated urban system rather than as isolated investment in cultural infrastructure or flagship projects.

II. LITERATURE REVIEW

Comparative mapping of European creative industries demonstrates that sectoral composition, occupational structure, and spatial concentration vary markedly across regional systems, making a single uniform creative-industry model inappropriate [1]. Related regional evidence shows that creative services influence productivity through differentiated local structures and knowledge linkages rather than through a universal metropolitan mechanism [2].

Research on creative hubs identifies a recurring tension between bottom-up autonomy and policy instrumentalization, indicating that intermediary creative spaces can support experimentation while also becoming tools of urban-development agendas [3]. Cultural heritage research similarly argues that heritage contributes to local development indirectly by stimulating several forms of creativity, enterprise, and place-based capability rather than through tourism alone [4]. Quantitative regional analysis further shows that contextual economic efficiency and enabling conditions strengthen or constrain cultural vibrancy and the creative economy [5].

Evidence on creative labor warns that sectoral expansion can coexist with employment insecurity, limited protection, and unequal access to opportunity [6]. Cultural-participation research associates access to cultural experiences with wider well-being outcomes, while also showing that participation opportunities are socially uneven [7]. These findings indicate that creative visibility should not be interpreted as inclusive urban benefit without considering access, labor conditions, and distribution.

Cultural-sustainability scholarship identifies several strategic pathways through which culture may function within, for, or as sustainable development [8]. Econometric evidence from a developing economy finds that creative industries can contribute to regional productivity, although effects differ substantially across subsectors and locations [9]. Spatial analysis in the same national context shows that urban scale, knowledge resources, and market access shape where traditional and knowledge-intensive creative activities are located in different ways [10].

Policy analysis in developing contexts shows that national creative-economy labels and promotional strategies do not automatically generate productive local ecosystems; institutional capacity, sectoral capability, and spatial context remain decisive [11]. Cross-border territorial evidence likewise indicates that intermediaries linking firms, knowledge institutions, and places can strengthen the contribution of creative industries to sustainable innovation [12].

A regional hub study demonstrates that networks, institutional coordination, and cross-sector collaboration help translate creative activity into innovation capacity [13]. Critical urban analysis cautions that successful creative-city strategies may simultaneously intensify housing pressure, segregation, and unequal access to opportunity [14]. Urban cultural-policy research further shows that governance, land development, institutional priorities, and community claims shape creative-city making [15].

Large-scale digital-trace analysis links urban cultural capital to economic success and neighborhood change, supporting multi-source evidence in comparative city research [16]. Grassroots cultural experiments show that culture can generate local knowledge and civic capability when communities meaningfully influence decisions [17]. Case-based urban-revitalization research adds that durable outcomes depend more on long-term networks and planning than on temporary promotional events [18].

Research on cultural and creative industries in Chinese urban redevelopment shows that regeneration, branding, and land-use transformation produce different outcomes under different governance pressures [19]. A case study of creative clustering in Valletta similarly reports increased activity and visibility alongside contested identity, tourism pressure, and conflict over central urban space [20]. Comparative work on non-Western creative hubs finds that collaborative spaces may also reproduce exclusions associated with property markets, funding structures, and access [21].

Regional-strategy research suggests that creativity strengthens tourism and innovation when it is integrated into smart-specialization capabilities rather than treated as an isolated cultural program [22]. Composite-indicator development operationalizes cultural vibrancy, the creative economy, and the enabling environment as separate but connected urban dimensions [23]. The updated monitoring framework confirms persistent differences among cities of varying size and institutional context, reinforcing the need for transparent dimension-specific interpretation [24].

Spatial evidence from Poland shows that creative industries and clusters remain geographically concentrated, so policy must account for uneven location advantages [25]. Practice-based urban-revitalization research identifies co-creation, adaptive reuse, and community participation as mechanisms that connect cultural activity to inclusive place development [26]. Foundational creative-city analysis explains the importance of cognitive-cultural production while warning that growth may deepen inequality when labor markets, housing, and governance are neglected [27].

Research focused on smaller cities argues that sustainable creative strategies require local embeddedness, institutional cooperation, realistic scale, and access to wider networks [28]. A historical reassessment of the creative-city approach documents a shift from narrow competitiveness toward participation, ecological transition, and social justice [29]. Conceptual work on the culture-sustainability relationship distinguishes culture as an independent domain, a mediator of transformation, and a foundation of development [30].

International urban-policy synthesis presents cultural assets as resources for regeneration, livelihoods, social cohesion, and city identity, while emphasizing the importance of governance, finance, and equitable access [31]. Evidence from small cities similarly shows that identity, entrepreneurship, and participation can support sustainable development when policies are tailored to local capabilities and constraints [32].

Taken together, the alphabetically organized evidence shows that cultural resources alone are insufficient. Wider urban benefits emerge most consistently when cultural provision is connected to entrepreneurship, education, digital participation, inclusion, institutional coordination, and effective governance.

Table 1. Comparative synthesis of the studies.

Ref.	Study and setting	Approach	Principal contribution and remaining issue
[1]	Boix et al. (2016), Europe	Comparative sector mapping	Creative industries vary across regional systems and cannot be treated as a uniform sector.
[2]	Boix-Domenech and Soler-Marco (2017), European regions	Regional econometric analysis	Creative services contribute through differentiated local productivity structures.
[3]	Boswinkel and van Meerkerk (2022), creative hubs	Policy and case analysis	Bottom-up autonomy and policy instrumentalisation coexist in urban hub development.
[4]	Cerisola (2019), European localities	Theoretical and econometric analysis	Cultural heritage affects development indirectly through multiple forms of creativity.
[5]	Cerisola and Panzera (2021), European regions	Efficiency and city-indicator analysis	Contextual efficiency catalyzes cultural vibrancy and creative-economy performance.
[6]	Comunian and England (2020), creative labor	Sectoral labour analysis	Creative growth can coexist with precarity and uneven social protection.
[7]	Crociata et al. (2014), cultural participation	Exploratory social-indicator analysis	Cultural access is associated with well-being; participation opportunities are uneven.
[8]	Duxbury et al. (2017), cultural policy	Conceptual policy synthesis	Identifies distinct strategic paths linking culture and sustainable development.
[9]	Fahmi and Koster (2017), regional productivity	Econometric regional analysis	Creative industries are associated with productivity, with substantial subsectoral variation.

Ref.	Study and setting	Approach	Principal contribution and remaining issue
[10]	Fahmi, Koster, and van Dijk (2016), Indonesia	City and regional location analysis	Urban scale and knowledge resources shape where different creative activities take place.
[11]	Fahmi, McCann, and Koster (2016), Indonesia	Policy and spatial analysis	National creative-economy labels require place-specific capability and institutional support.
[12]	Faraone et al. (2022), cross-border region	Territorial project analysis	Intermediaries connect creative firms, institutions, and sustainable innovation.
[13]	Fleischmann, Daniel, and Welters (2017), Australia	Regional hub case study	Networks and institutional coordination help translate creative activity into innovation.
[14]	Florida (2017), global urban development	Critical urban synthesis	Creative-city success can coexist with affordability, segregation, and opportunity gaps.
[15]	Grodach (2017), urban cultural policy	Policy review	Governance, development interests, and community claims shape creative city-making.
[16]	Hristova, Aiello, and Quercia (2018), cities	Digital-trace and economic analysis	Urban cultural capital relates to economic success and neighborhood change.
[17]	Jeannotte and Duxbury (2015), local cultural experiments	Comparative practice analysis	Grassroots culture generates knowledge and civic capability when communities influence decisions.
[18]	Lei (2021), urban revitalization	Case-based policy analysis	Long-term networks and planning are more important than short promotional events.
[19]	Liang and Wang (2020), China	Review of urban redevelopment	Creative industries support regeneration and branding, but governance conditions matter.
[20]	Markwick (2018), Valletta	Urban regeneration case study	Creative clustering produces visibility but also contested identity and tourism pressures.
[21]	Mert-Travlos (2021), non-Western hubs	Comparative hub analysis	Creative hubs enable collaboration but may reproduce access and property exclusions.
[22]	Meyer et al. (2022), smart specialisation	Regional strategy analysis	Creativity strengthens tourism and innovation when integrated into regional capabilities.
[23]	Montalto et al. (2017), European cities	Composite-indicator development	Operationalizes cultural vibrancy, the creative economy, and the enabling environment.
[24]	Montalto et al. (2019), European cities	Updated city-monitor methodology	Shows persistent differences in creative performance and enabling conditions.
[25]	Namyślak (2022), Poland	Spatial concentration analysis	Creative industries remain geographically concentrated and unevenly distributed.
[26]	Navarrete et al. (2020), urban revitalisation	Practice-based handbook and cases	Co-creation, adaptive reuse, and participation connect culture with inclusive regeneration.

Ref.	Study and setting	Approach	Principal contribution and remaining issue
[27]	Scott (2014), advanced urban economies	Conceptual and regional synthesis	Cognitive-cultural production can support growth but may deepen inequality; mechanisms require social and institutional analysis.
[28]	Sdrali (2020), small cities	Sustainable-development synthesis	Smaller cities require embedded and scale-sensitive creative strategies.
[29]	Segovia and Hervé (2022), creative-city approach	Historical and conceptual review	Creative-city strategy is shifting toward participation, justice, and transition.
[30]	Soini and Dessein (2016), culture-sustainability relation	Interdisciplinary framework	Culture can be a domain, mediator, or foundation of sustainability.
[31]	World Bank and UNESCO (2021), global cities	International evidence synthesis	Culture supports livelihoods and cohesion when governance, finance, and access align.
[32]	Zemite et al. (2022), small cities	Mixed evidence and policy analysis	Identity, entrepreneurship, and participation contribute when tailored support exists.

III. RESEARCH GAP

While literature links culture to development and innovation, four gaps persist: single-metric bias (focusing only on employment or venues), limited geographic scope (single-region studies), opaque rankings (untested ecosystem dimensions), and economic overemphasis (neglecting social and environmental outcomes).

This study resolves these gaps by applying a three-dimensional comparative index to an international sample of cities, evaluating dimension-specific scores against four sustainability outcomes, and validating findings against independent climate and prosperity indicators.

IV. CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

The framework treats cultural amenities, creative entrepreneurship, and enabling conditions as complementary inputs. Their integration is expected to relate differently to people, planet, profit, and overall outcomes rather than producing one uniform effect.

Cultural amenities can increase place attractiveness, participation, tourism, and symbolic identity. However, the literature suggests that their effect may remain limited when access, affordability, and institutional capacity are weak. H1 therefore proposes that cultural amenities are positively associated with overall sustainable urban performance, while recognizing that the adjusted effect may be modest.

Creative entrepreneurship provides a mechanism for transforming ideas into employment, firms, products, and services. Start-up ecosystems, venture finance, and business freedom should be most directly connected with economic vitality. H2 proposes that creative entrepreneurship is positively associated with the profit dimension of sustainable urban performance.

Enabling conditions influence who can create, participate, communicate, and benefit. Education expands knowledge capabilities, digital access lowers information and market barriers, and tolerance supports diversity and attracts talent. H3 proposes that enabling conditions are positively associated with people-centered and overall sustainable urban performance.

Because the three dimensions address different stages of urban creative capacity, their combined effect should be more stable than any single component. H4 proposes that the integrated Creative-Ecosystem

Capacity Index is positively associated with overall sustainable urban performance after accounting for connectivity, cost conditions, and regional differences.

Cities may achieve similar aggregate positions through different combinations of strengths and weaknesses. Cluster analysis should therefore reveal balanced leaders, culturally visible but institutionally constrained cities, and lower-capacity transitional cities. H5 proposes that cities with balanced creative-ecosystem profiles display stronger overall sustainable performance than cities with fragmented profiles.

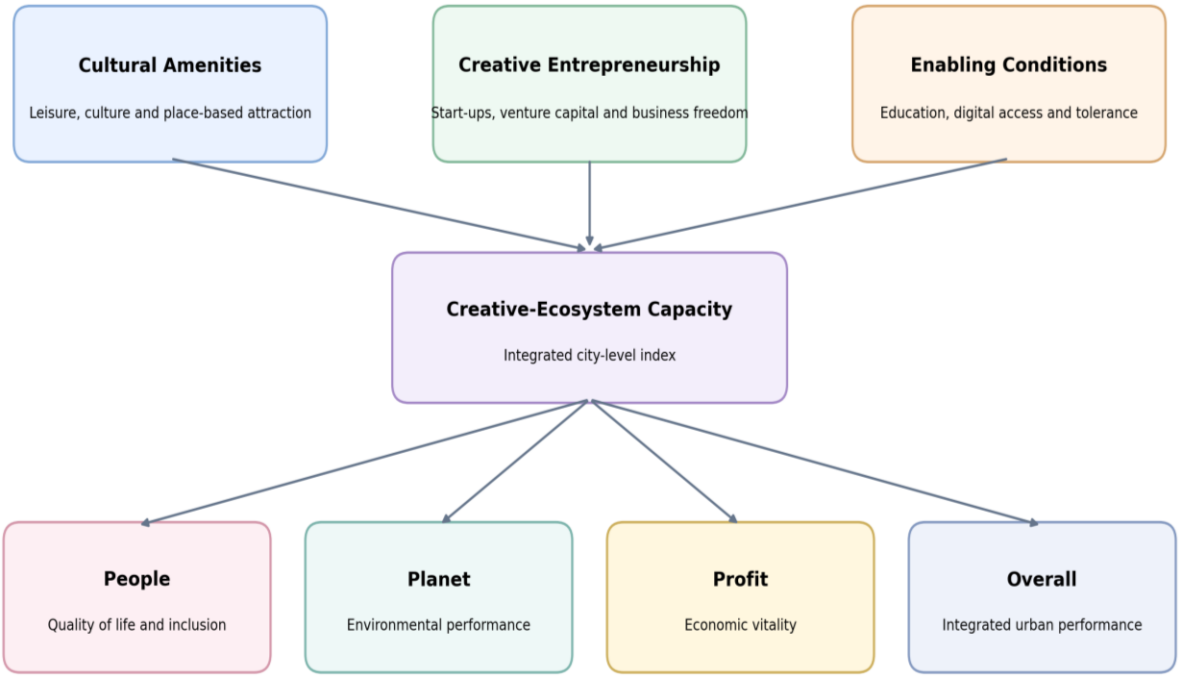


FIGURE 1. Conceptual framework linking creative-ecosystem capacity to sustainable urban performance.

V. PROPOSED METHOD

The proposed method is a multi-source urban ecosystem assessment designed to preserve the conceptual distinction between cultural provision, entrepreneurial capacity, enabling conditions, and sustainable outcomes. Rather than pooling every available variable into an opaque score, the method uses a staged architecture. The first stage constructs three theory-informed dimensions from city-level indicators. The second stage integrates the dimensions using equal standardized weights. The third stage evaluates associations with four sustainable-city outcomes. The fourth stage identifies urban profiles. The final stage tests external validity with independent governance and prosperity indicators. The method is deliberately conservative. Rankings are converted so that higher values consistently indicate better performance, but Spearman correlation remains the principal bivariate measure because rank intervals cannot be assumed equal. We use robust linear regression as a supplementary model to estimate adjusted score differences while reducing sensitivity to heteroskedasticity. Principal-component analysis tests whether the equal-weight index reflects the dominant empirical structure. Cluster analysis identifies recurring configurations rather than imposing a single linear hierarchy.

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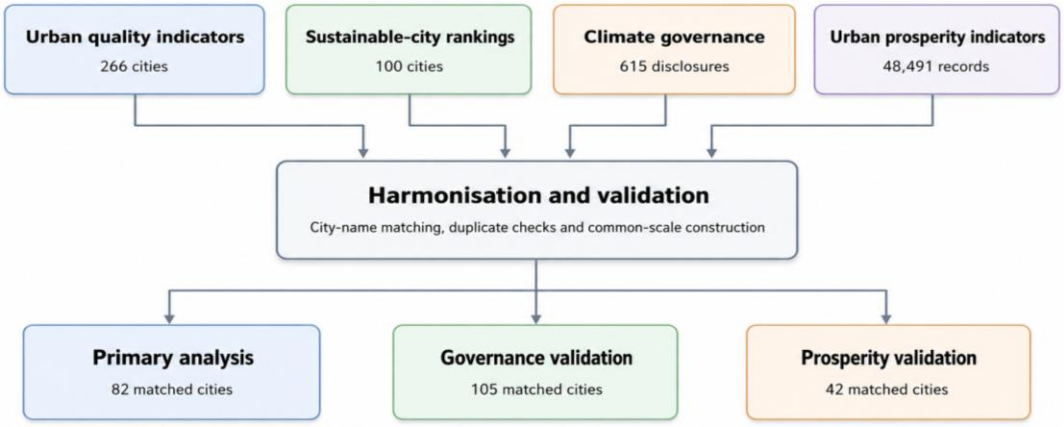


FIGURE 2. Analytical data architecture and validation samples.

VI. METHODOLOGY

1. RESEARCH DESIGN

The study adopts a quantitative, cross-sectional, comparative city design. The unit of analysis is the city. The primary model examines 82 cities appearing in both the urban-quality and sustainable-city sources. We analyze two secondary samples separately: 105 cities with climate-governance information and 42 cities with multidimensional prosperity indicators. This separated-sample strategy prevents the extensive loss of observations that would result from requiring every city to appear in all sources.

The research is explanatory in the statistical sense but non-causal in interpretation. It evaluates whether systematic associations remain after accounting for selected city conditions and regional categories. No temporal ordering, natural experiment, or instrumental variable is available. The analysis therefore does not claim that creative ecosystems independently cause sustainability; reverse influence and common institutional causes remain possible.

2. DATA SOURCES AND ANALYTICAL SAMPLES

Table 2. Public indicator sources and their analytical roles.

Source family	Original coverage	Selected information	Analytical role
Urban quality indicators	266 city observations	Cultural amenity, start-ups, venture finance, business freedom, education, digital access, tolerance, connectivity, cost conditions	Primary predictor construction
Sustainable-city rankings	100 cities	People, planet, profit, and overall positions	Primary outcome construction
Climate-governance disclosures	615 organizational records	Planning targets, risk assessment, adaptation, emissions governance, renewable energy, efficiency, and water strategy	External governance validation
Urban prosperity indicators	48,491 records across multiple geographical levels	Quality of life, productivity, environment, equity, infrastructure, and city prosperity	External prosperity validation

Source family	Original coverage	Selected information	Analytical role
World heritage inventory	1,199 sites	Heritage category, coordinates, criteria, and inscription information	Screened but excluded from city-level models because reliable city attribution was unavailable

3. SAMPLE SELECTION AND INCLUSION CRITERIA

We included cities in the primary sample when their standardized city names matched across the urban-quality and sustainable-city sources. We converted names to lowercase, removed accents and punctuation, and harmonized common variants. We resolved duplicate place names using geographical information; for example, we matched the internationally ranked Birmingham and Portland observations to the United Kingdom and Oregon entries, respectively. Exact matching produced 82 cities. Eighteen ranked cities did not have a corresponding urban-quality observation and were excluded.

The governance validation sample required a match between the urban-quality source and an identifiable city disclosure. Where multiple disclosures referred to the same city, indicator responses were aggregated after categorical recoding. The prosperity validation sample retained city-level rather than national records and selected the latest available observation for each indicator-city combination. Cities with insufficient information for an index or outcome were omitted on an analysis-specific basis.

4. VARIABLES, MEASURES, AND CODING FRAMEWORK

Table 3. Variables and operational definitions.

Construct	Indicators	Operational meaning	Coding
Cultural amenities	Leisure and culture score	Urban access to cultural and leisure experiences	Standardised z-score
Creative entrepreneurship	Start-ups, venture capital, business freedom	Capacity to form, finance, and operate innovative organizations	Mean of standardised indicators
Enabling conditions	Education, internet access, tolerance	Knowledge, digital participation, and inclusive talent environment	Mean of standardized indicators
Creative-Ecosystem Capacity Index	Three dimension scores	Integrated creative capacity	Standardized equal-weight mean
People outcome	People rank	Quality of life and inclusion	Reversed rank score
Planet outcome	Planet rank	Environmental urban performance	Reversed rank score
Profit outcome	Profit rank	Economic vitality and opportunity	Reversed rank score
Overall outcome	Overall rank	Integrated sustainable-city position	Reversed rank score

Construct	Indicators	Operational meaning	Coding
Controls	Travel connectivity, cost of living, continent	Accessibility, cost structure, and regional context	Standardized continuous controls and regional categories

The label creative ecosystem is used rather than cultural and creative industries because the available predictors measure amenities and enabling conditions, not direct sectoral employment or firm revenue.

We standardized each continuous indicator before aggregation to prevent variables with larger numerical dispersion from dominating the composite measures. The transformation is expressed in Equation (1).

$$z_{ij} = (x_{ij} - \bar{x_j}) / s_j \quad (1)$$

where x_{ij} is the value for city i on indicator j, $\bar{x_j}$ is the sample mean, and s_j is the sample standard deviation. The dimension scores were then combined as shown in Equation (2).

$$CEI_i = (CA_i + CR_i + EC_i) / 3 \quad (2)$$

CA denotes cultural amenities, CR denotes creative entrepreneurship, and EC denotes enabling conditions. Sustainable-city ranks were reversed so that higher values indicated stronger performance.

$$S_id = 101 - R_id \quad (3)$$

5. ANALYTICAL PROCEDURE

First, we calculated descriptive statistics to assess range, central tendency, and dispersion. Second, we evaluated monotonic relationships between the ecosystem dimensions and rank-based outcomes using Spearman correlations. Third, we divided cities into Creative-Ecosystem Capacity Index quartiles to provide an interpretable comparison of outcome gradients. Fourth, we estimated heteroskedasticity-robust ordinary least squares models to adjust associations while controlling for travel connectivity, cost of living, and continent.

Fifth, dimension-specific models entered cultural amenities, creative entrepreneurship, and enabling conditions simultaneously to identify their independent patterns. Sixth, we used principal-component analysis to assess whether a data-derived weighting structure produced a city ordering similar to the equal-weight index. Seventh, we estimated k-means cluster analysis for alternative cluster counts, using the silhouette statistic to select the most coherent solution. Finally, we tested the creative-ecosystem measure against an independently constructed sustainability-governance index and selected urban-prosperity indicators.

The adjusted model is represented in Equation (4).

$$S_id = \beta_0 + \beta_1 CEI_i + \beta_2 TC_i + \beta_3 CL_i + \Sigma_r \gamma_r Region_{ir} + \varepsilon_i \quad (4)$$

S_id denotes the score of city i for sustainability dimension d; CEI is the creative-ecosystem index; TC is travel connectivity; CL is cost of living; and regional categories absorb broad geographical differences. Robust standard errors were used for inference.

6. VALIDITY, RELIABILITY, AND ETHICAL CONSIDERATIONS

We strengthened construct validity by aligning each dimension with established creative-city and cultural-sustainability frameworks. We evaluated convergent validity through correlations between the component dimensions and the integrated index. Criterion validity was assessed through the two independent validation sources. The governance index used nine planning and target indicators, while the

prosperity validation covered quality of life, productivity, environmental sustainability, equity, infrastructure, and overall city prosperity.

We addressed reliability through transparent coding and sensitivity analysis rather than internal-consistency claims, which would be inappropriate for formative urban indicators. The equal-weight index was compared with a principal-component score; their near-identical city ordering indicates that the substantive findings do not depend on the selected weighting rule. City matching, duplicate resolution, reverse coding, and missing-data decisions were applied consistently and documented in the appendices.

The study uses aggregated, publicly available city information and does not contain individual participants, personal identifiers, or private behavioural records. Human-participant consent was therefore not applicable. Ethical responsibility nevertheless requires avoiding stigmatizing interpretations of low-ranked cities and recognizing that rankings reflect indicator choices, reporting capacity, and institutional context. Results are discussed as comparative signals for policy diagnosis rather than definitive judgments of city quality.

VII. RESULTS

1. DESCRIPTIVE PROFILE

Table 4. Descriptive statistics for the primary city sample.

Variable	N	Mean	SD	Minimum	Maximum
Leisure and culture	82	6.95	1.94	0.00	10.00
Start-ups	82	6.30	2.16	0.00	10.00
Venture capital	82	4.69	2.47	0.00	10.00
Education	82	4.72	2.44	0.00	9.71
Internet access	82	5.36	1.78	1.00	9.72
Tolerance	82	6.25	1.87	1.53	9.60
Creative-Ecosystem Capacity Index	82	0.00	1.01	-2.59	2.05
People score	82	52.57	29.69	1.00	100.00
Planet score	82	55.67	28.33	3.00	100.00
Profit score	82	54.28	27.01	2.00	100.00
Overall score	82	55.44	28.04	2.00	100.00

The wide ranges indicate substantial international variation. Venture capital and education show especially strong dispersion, supporting standardization before index construction.

The primary sample contains cities across multiple continents and development contexts. The mean overall sustainable-city score was 55.44, but the near-full range demonstrates that the sample is not confined to high-performing cultural capitals. The creative-ecosystem index also spans more than four standard deviations, creating sufficient variation for comparative analysis.

2. CORRELATION ANALYSIS

Table 5. Spearman correlations between creative-ecosystem measures and sustainable-city outcomes.

Predictor	People	Planet	Profit	Overall
Cultural amenities	.070	.032	.241	.134
Creative entrepreneurship	.245	.270	.573***	.436***
Enabling conditions	.558***	.621***	.622***	.739***
Creative-Ecosystem Capacity Index	.347**	.372***	.632***	.544***

Values are Spearman rho coefficients. ** p < .01; *** p < .001. Enabling conditions show the most consistent bivariate associations, while cultural amenities alone have weak relationships with the outcomes.

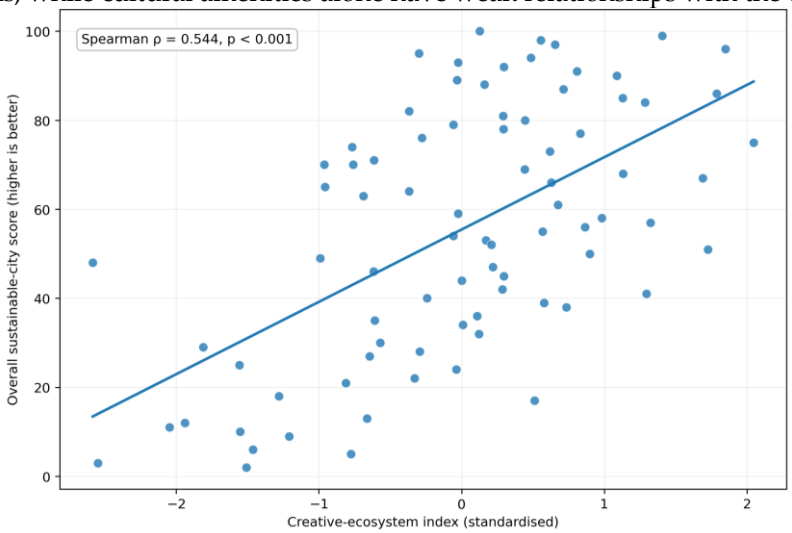


FIGURE 3. Creative-Ecosystem Capacity Index and overall sustainable urban performance.

The positive monotonic relationship is visible across the sample, but the dispersion around the fitted line confirms that creative capacity is not sufficient on its own. Cities with similar ecosystem scores can occupy different sustainability positions because of governance, infrastructure, cost, and historical conditions.

The integrated index correlated positively with all four outcomes. It was strongest with profit (rho = .632), followed by overall performance (rho = .544). Enabling conditions produced even stronger bivariate relationships with overall (rho = .739), planet (rho = .621), and profit (rho = .622) scores. Cultural amenities alone were not strongly related to the outcomes, indicating that cultural visibility without complementary capacity provides a weak explanation of comparative sustainability.

3. QUARTILE COMPARISON

Table 6. Mean overall and people-centered scores by creative-ecosystem quartile.

Creative-ecosystem group	N	Overall score	People score
Lowest quartile (Q1)	21	30.00	33.29
Second quartile (Q2)	20	55.05	55.95
Third quartile (Q3)	20	65.05	61.00
Highest quartile (Q4)	21	72.10	60.62

Overall performance rises progressively across quartiles. The people-centered outcome improves sharply from the lowest group, then levels off among the upper groups, suggesting threshold or contextual effects.

Cities in the highest creative-ecosystem quartile recorded an average overall score of 72.10, compared with 30.00 in the lowest quartile. The difference of more than 42 points is substantively large. The people-centered score rose from 33.29 in the lowest group to above 60 in the two highest groups, but the upper-quartile difference was limited. This suggests that creative capacity may be especially important in avoiding weak performance, while affordability, inequality, housing, health, and other institutional factors distinguish cities at the upper end.

4. ROBUST REGRESSION RESULTS

Table 7. Adjusted association of the Creative-Ecosystem Capacity Index with sustainable-city outcomes.

Outcome	B	Robust SE	95% CI	p	Adjusted R^2
Overall	6.137	2.922	0.410 to 11.863	.036	.761
People	4.526	2.705	-0.775 to 9.827	.094	.616
Planet	0.041	2.647	-5.148 to 5.230	.988	.645
Profit	11.477	4.383	2.886 to 20.069	.009	.574

Each coefficient represents the score difference associated with a one-standard-deviation increase in creative-ecosystem capacity, controlling for connectivity, cost of living, and continent. N = 82.

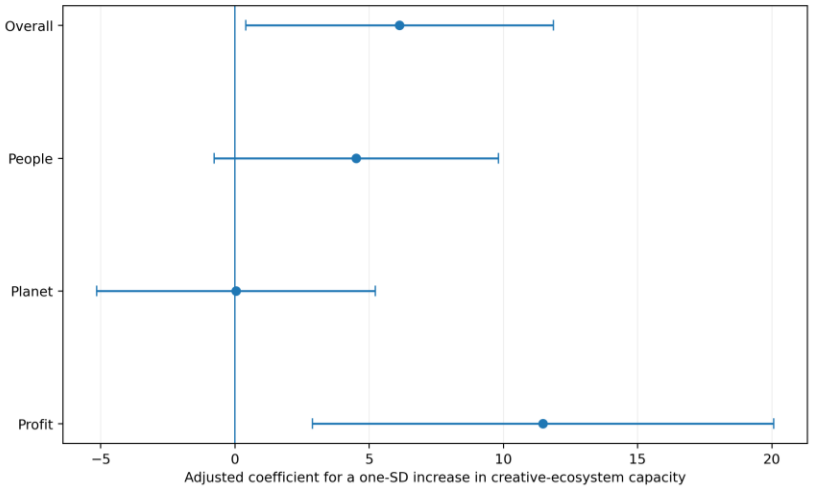


FIGURE 4. Adjusted creative-ecosystem associations across sustainability dimensions.

Confidence intervals exclude zero for the overall and profit models. The near-zero planet coefficient indicates that creative capacity does not explain environmental performance after the selected controls are included.

A one-standard-deviation increase in the integrated index was associated with a 6.14-point increase in overall sustainable-city performance. The relationship remained statistically significant after we added control variables and regional categories. The largest adjusted coefficient occurred for profit: a one-standard-deviation increase corresponded to an 11.48-point higher economic score. The people coefficient was positive but did not meet the conventional significance threshold, and the planet coefficient was effectively zero. These results support an integrated ecosystem association but reject the assumption that creative capacity relates equally to every sustainability dimension.

5. DIMENSION-SPECIFIC MODELS

Table 8. Dimension-specific robust regression results.

Outcome	Ecosystem dimension	B	p
Overall	Cultural amenities	-0.290	.872
Overall	Creative entrepreneurship	5.625	.089
Overall	Enabling conditions	12.777	.011
People	Cultural amenities	-0.410	.870
People	Creative entrepreneurship	1.917	.667
People	Enabling conditions	14.717	.046
Planet	Cultural amenities	-3.847	.071
Planet	Creative entrepreneurship	4.582	.301

Outcome	Ecosystem dimension	B	p
Planet	Enabling conditions	7.019	.223
Profit	Cultural amenities	3.762	.190
Profit	Creative entrepreneurship	8.345	.069
Profit	Enabling conditions	10.292	.118

Models include all three ecosystem dimensions simultaneously with connectivity, cost, and continent controls. Enabling conditions are independently associated with overall and people outcomes; cultural amenities do not show an independent positive effect.

The disaggregated models explain why the composite index performs differently across outcomes. Enabling conditions were positively associated with overall performance (B = 12.78, p = .011) and people-centered performance (B = 14.72, p = .046). Creative entrepreneurship showed positive but marginal relationships with overall and profit outcomes. Cultural amenities were not independently significant in any adjusted model. This finding does not imply that culture lacks value; it indicates that a broad leisure-and-culture score does not, by itself, distinguish sustainable cities once entrepreneurial, educational, digital, and regional conditions are considered.

6. SENSITIVITY AND CLUSTER ANALYSIS

Principal-component analysis produced a first component explaining 59.54% of the variation across the three ecosystem dimensions. The rank correlation between the principal-component score and the equal-weight index was .980 ($p < .001$). This near-equivalence suggests the city ordering is not an artifact of equal weighting and supports the composite measure's robustness.

Table 9. Three-cluster profile solution.

Urban profile	N	Culture z	Entrepreneurship z	Enabling z	People	Planet	Profit	Overall
Balanced creative leaders	42	.34	.54	.54	61.40	65.26	69.33	68.98
Amenity-rich but constrained	23	.48	-.66	-.63	42.13	40.13	38.96	39.17
Low-amenity transitional	17	-1.51	-.45	-.49	44.88	53.00	37.82	44.00

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The three-cluster solution achieved the strongest silhouette statistic among the tested alternatives. Balanced leaders outperform the two fragmented profiles across every outcome.

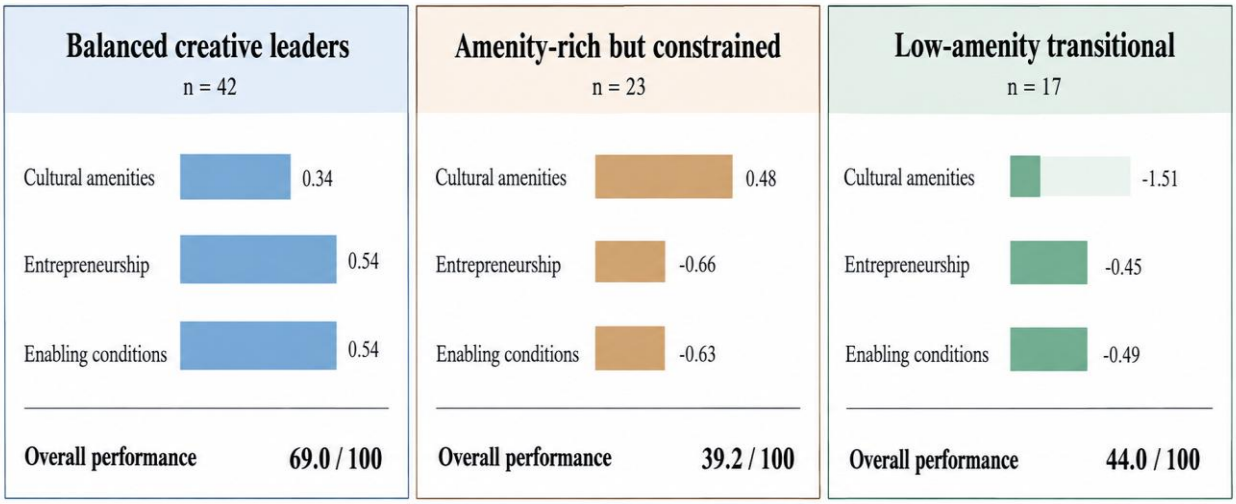


FIGURE 5. Creative-ecosystem and sustainability profiles of the three city clusters.

- Analytical interpretation. Cultural amenities without entrepreneurship and enabling conditions do not produce a high-performing profile. The balanced cluster combines moderate-to-high values across all dimensions and records the strongest sustainable outcomes.

The cluster solution provides a policy-relevant interpretation that is not visible in a single ranking. Forty-two cities formed a balanced-leader group with above-average values across all ecosystem dimensions and the highest mean overall score. Twenty-three cities were amenity-rich but constrained: cultural provision was relatively strong, while entrepreneurship and enabling conditions were below average. Their overall score was substantially lower. The third cluster combined very weak cultural amenities with below-average entrepreneurial and enabling capacity. These patterns support the proposition that balance across dimensions is more consequential than isolated cultural strength.

7. EXTERNAL VALIDATION

Table 10. External validation results.

Validation outcome	N	Effect	p	Interpretation
Sustainability-governance index	105	.487	< .001	Positive correlation with planning, risk, adaptation, energy, and water-governance commitments
Governance regression	105	B = .116	.001	Positive adjusted relationship after population and continent controls
Quality-of-life index	42	.799	< .001	Strong positive external association
Productivity index	42	.883	< .001	Strongest prosperity-validation relationship
Environmental sustainability index	42	.691	< .001	Positive relationship under an alternative environmental measure

Validation outcome	N	Effect	p	Interpretation
Equity index	42	.411	.007	Moderate relationship with distributive urban performance
Infrastructure development index	42	.826	< .001	Strong relationship with urban capacity
City prosperity index	42	.829	< .001	Strong overall criterion validity

We analyzed governance and prosperity indicators in separate samples. Their consistent positive relationships with creative-ecosystem capacity reduce the likelihood that the primary findings are specific to one ranking system.

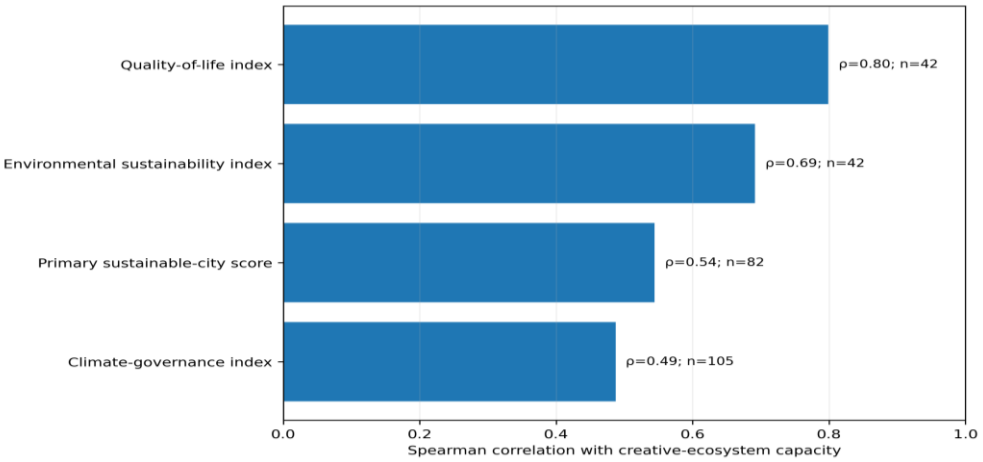


FIGURE 6. External validation correlations for governance and urban prosperity outcomes.

The index is related not only to the primary sustainable-city ranking but also to independent measures of governance, productivity, infrastructure, equity, and prosperity. This supports criterion validity while remaining consistent with non-causal interpretation.

8. HYPOTHESIS EVALUATION

Table 11. Summary of hypothesis tests.

Hypothesis	Expectation	Decision	Evidence
H1	Cultural amenities are positively associated with overall performance.	Not supported	The adjusted coefficient was near zero and non-significant.
H2	Creative entrepreneurship is positively associated with profit.	Partially supported	The bivariate association was strong; the dimension-specific adjusted coefficient was positive but marginal, while the integrated index strongly predicted profit.
H3	Enabling conditions are positively associated with people and overall outcomes.	Supported	Both adjusted coefficients were positive and statistically significant.

Hypothesis	Expectation	Decision	Evidence
H4	The integrated ecosystem index is positively associated with overall performance.	Supported	The adjusted overall coefficient was positive and significant.
H5	Balanced creative profiles outperform fragmented profiles.	Supported	The balanced-leader cluster had the highest scores across all outcomes.

The results support an ecosystem interpretation but do not support a venue-centred or amenity-only explanation of sustainable urban performance.

VIII. DISCUSSION

The findings refine the common claim that cultural and creative industries drive sustainable urban development. The primary conclusion is not that culture is unimportant, but that visible cultural provision is insufficient as an independent explanation of comparative city performance. Cultural amenities showed only weak bivariate relationships and no positive adjusted effect. By contrast, the integrated ecosystem index was associated with overall and economic outcomes, and enabling conditions were the most consistent independent dimension. This pattern supports theories that treat urban creativity as a capability system rather than a collection of venues or events.

The result is consistent with the literature's shift from flagship-led creative-city strategies toward more relational approaches. Cultural districts and institutions can generate identity, footfall, and symbolic value, but they require education, access, openness, digital connectivity, finance, and organisational freedom to produce wider benefits. A city can host extensive cultural consumption while offering limited pathways for residents to create enterprises, access knowledge, or participate in decision-making. The amenity-rich but constrained cluster provides an empirical representation of this condition.

The strong association with the profit dimension indicates that creative ecosystems are most directly connected with economic vitality. This is plausible because start-up activity, venture finance, business freedom, education, and digital access are closely related to innovation and market formation. However, the finding should not be interpreted as proof that cultural spending raises city income. The index contains general entrepreneurial conditions, and economically successful cities can invest more in both culture and enabling infrastructure. The relationship is therefore best understood as mutual reinforcement within an urban development system.

The people-centred results are more nuanced. The integrated index had a positive but statistically uncertain adjusted coefficient, whereas enabling conditions were independently significant. This suggests that social benefits depend less on cultural abundance than on the accessibility of the wider urban environment. Education, internet access, and tolerance increase the likelihood that residents can participate in cultural and economic life. They also influence the capacity of cities to attract diverse workers and support social interaction. The upper-quartile plateau further indicates that creative capacity alone may not overcome affordability, inequality, healthcare, or housing constraints in already advanced cities.

The planet result challenges overly broad sustainability claims. The bivariate correlations were positive, especially for enabling conditions, but the adjusted composite coefficient was effectively zero. Environmental performance is shaped by energy systems, transport infrastructure, land-use regulation, industrial structure, climate exposure, and national policy. Cultural and creative capacity may support environmental communication, design innovation, and public engagement, yet these indirect pathways are unlikely to substitute for material infrastructure and regulatory action. The independent prosperity validation nevertheless showed a substantial relationship with an alternative environmental index, suggesting that measurement and sample composition matter.

External validation strengthens the central argument. Creative-ecosystem capacity correlated with the sustainability-governance index and remained significant after population and regional controls. Cities with stronger creative ecosystems were more likely to report planning targets, risk assessment, adaptation,

emissions governance, energy commitments, and water strategies. This may reflect stronger institutional capacity, more active civic networks, or higher reporting capability. It does not establish that creative sectors create climate governance, but it demonstrates that the ecosystem measure is connected with broader urban coordination.

The prosperity validation was particularly strong. Correlations with productivity, infrastructure, quality of life, and overall prosperity exceeded those found in the primary ranking sample. These independent outcomes align with the theoretical expectation that creativity operates through interconnected urban capabilities. The moderate equity correlation is also informative: creative capacity is associated with distributive conditions, but much less strongly than with productivity or infrastructure. This reinforces critical concerns that creative urban growth can coexist with unequal access and displacement.

The cluster analysis offers a more actionable interpretation than regression alone. Balanced leaders combine cultural provision, entrepreneurial mechanisms, and enabling conditions. Amenity-rich but constrained cities demonstrate that cultural visibility may not translate into sustainable outcomes when business formation and inclusive capability are weak. Low-amenity transitional cities require a different strategy: strengthening basic cultural access should occur alongside education, digital infrastructure, and local enterprise support. The profiles therefore discourage one-size-fits-all creative-city policy.

Taken together, the evidence supports a conditional account of culture-led development. Cultural resources matter when they are connected to institutions that enable creation, participation, circulation, and reinvestment. Policies focused exclusively on tourism branding, iconic architecture, or event calendars risk producing temporary visibility without durable capability. Conversely, entrepreneurship policies that ignore cultural identity and public space may generate firms without strengthening belonging or place quality. Sustainable urban development requires coordination across cultural, economic, social, spatial, and environmental policy domains.

The study also demonstrates the value of methodological restraint. Forcing every source into a single complete-case sample would have reduced the sample to a level unsuitable for a multi-variable city model. Separate validation samples preserved information and provided a clearer test of whether the main relationship generalised. Likewise, excluding the heritage-site inventory from the regression prevented an arbitrary spatial allocation procedure from creating false precision. These decisions improve credibility even though they reduce the number of cultural variables in the final model.

Table 12. Profile-specific policy responses.

City profile	Strategic priority	Illustrative policy package	Monitoring focus
Balanced creative leaders	Maintain coordination; address affordability and unequal access	Affordable creative space, inclusive procurement, neighbourhood participation, environmental integration	Retention, distribution of benefits, access by neighbourhood and group
Amenity-rich but constrained	Convert cultural visibility into productive and inclusive capability	Incubators, finance, skills partnerships, digital access, small-firm support	New local enterprises, survival rates, local employment, participation breadth
Low-amenity transitional	Build foundational cultural and enabling infrastructure together	Community cultural spaces, libraries, broadband, education, public realm, mobility	Access, skills, local participation, first-stage enterprise formation

XII. CONCLUSION

This study examined whether cultural amenities and wider creative-ecosystem conditions are associated with sustainable urban performance across global cities. The results provide a qualified answer. Cultural amenities alone did not independently explain stronger overall outcomes, whereas the integrated ecosystem measure was positively associated with overall and economic performance. Enabling conditions—education, digital access, and tolerance—were the most consistent individual dimension and were related to both overall and people-centred outcomes. Cities combining cultural provision, entrepreneurship, and enabling capacity formed a balanced-leader profile with substantially stronger people, planet, profit, and overall scores than fragmented profiles. Independent governance and prosperity analyses reproduced the positive pattern, supporting the validity of the framework beyond one city-ranking source. The evidence therefore shifts the policy question from whether culture is valuable to the conditions under which cultural and creative activity becomes developmentally consequential. Cultural infrastructure can strengthen identity, attraction, participation, and experimentation, but durable urban benefits depend on the ability of residents and organisations to access knowledge, form enterprises, use digital systems, collaborate across differences, and engage with capable public institutions. Environmental performance follows a more indirect pathway and requires material infrastructure and regulation alongside cultural engagement. The study's cross-sectional and proxy-based design requires cautious interpretation, and no causal claim is made. Nevertheless, the analysis offers a transparent empirical model for future research and policy evaluation. Cities should not pursue a universal creative-city formula. They should diagnose whether their principal constraint is cultural access, entrepreneurial conversion, enabling capability, social distribution, or institutional coordination, and then design integrated strategies accordingly. Sustainable culture-led development is most credible when creativity is treated not as a promotional label or isolated sector, but as a connected urban ecosystem whose benefits are intentionally broadened and governed.

Author Contributions

The author conducted the conceptualization, methodology, data analysis, investigation, writing, review, editing, and final approval of the manuscript.

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Data Availability

The dataset will be available from the author upon reasonable request.

Conflicts of Interest

The author declares no conflict of interest.

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Appendices

APPENDIX A. PRIMARY CITY SAMPLE

Table A1. Cities included in the primary matched sample.

City	Country	Continent
Cairo	Egypt	Africa
Nairobi	Kenya	Africa
Cape Town	South Africa	Africa
Johannesburg	South Africa	Africa
Beijing	China	Asia
Hong Kong	China	Asia
Shanghai	China	Asia
Bengaluru	India	Asia
Chennai	India	Asia
Mumbai	India	Asia
Jakarta	Indonesia	Asia
Tokyo	Japan	Asia
Kuala Lumpur	Malaysia	Asia
Manila	Philippines	Asia
Singapore	Singapore	Asia
Seoul	South Korea	Asia
Taipei	Taiwan	Asia
Bangkok	Thailand	Asia
Vienna	Austria	Europe
Brussels	Belgium	Europe
Prague	Czechia	Europe
Copenhagen	Denmark	Europe
Lyon	France	Europe
Paris	France	Europe
Berlin	Germany	Europe
Frankfurt	Germany	Europe

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City	Country	Continent
Hamburg	Germany	Europe
Munich	Germany	Europe
Athens	Greece	Europe
Dublin	Ireland	Europe
Milan	Italy	Europe
Rome	Italy	Europe
Amsterdam	Netherlands	Europe
Rotterdam	Netherlands	Europe
Warsaw	Poland	Europe
Lisbon	Portugal	Europe
Moscow	Russia	Europe
Barcelona	Spain	Europe
Madrid	Spain	Europe
Stockholm	Sweden	Europe
Geneva	Switzerland	Europe
Zurich	Switzerland	Europe
Istanbul	Turkey	Europe
Birmingham	U.K.	Europe
Edinburgh	U.K.	Europe
Glasgow	U.K.	Europe
Leeds	U.K.	Europe
London	U.K.	Europe
Manchester	U.K.	Europe
Doha	Qatar	Middle East
Riyadh	Saudi Arabia	Middle East
Dubai	UAE	Middle East
Montreal	Canada	North America
Toronto	Canada	North America
Vancouver	Canada	North America

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City	Country	Continent
Mexico City	Mexico	North America
Atlanta	U.S.	North America
Baltimore	U.S.	North America
Boston	U.S.	North America
Chicago	U.S.	North America
Dallas	U.S.	North America
Denver	U.S.	North America
Detroit	U.S.	North America
Houston	U.S.	North America
Indianapolis	U.S.	North America
Los Angeles	U.S.	North America
Miami	U.S.	North America
New Orleans	U.S.	North America
New York	U.S.	North America
Philadelphia	U.S.	North America
Pittsburgh	U.S.	North America
Seattle	U.S.	North America
Washington	U.S.	North America
Brisbane	Australia	Oceania
Melbourne	Australia	Oceania
Sydney	Australia	Oceania
Wellington	New Zealand	Oceania
Buenos Aires	Argentina	South America
Rio de Janeiro	Brazil	South America
Sao Paulo	Brazil	South America
Santiago	Chile	South America
Lima	Peru	South America

The sample contains 82 cities after name harmonization and duplicate-place resolution.

APPENDIX B. GOVERNANCE INDEX CODING

Table B1. Construction of the sustainability-governance validation index.

Indicator	Coding rule
Sustainability targets in master planning	Yes = 2; in progress/intended = 1; no or unknown = 0
Climate-risk assessment and actions	Completed = 2; in progress = 1; absent or unknown = 0
Adaptation plan	Adopted = 2; in progress = 1; absent or unknown = 0
City-wide emissions inventory	Available = 2; in progress = 1; absent or unknown = 0
Emissions-reduction target	Target reported = 2; no target or unknown = 0
Mitigation planning	Plan adopted = 2; in progress = 1; absent or unknown = 0
Renewable-energy target	Target adopted = 2; in progress = 1; absent or unknown = 0
Energy-efficiency target	Target adopted = 2; in progress = 1; absent or unknown = 0
Water-resource strategy	Strategy adopted = 2; in progress = 1; absent or unknown = 0

Available indicator scores were averaged by city. The validation index is a formative governance measure and was not evaluated with internal-consistency statistics.

APPENDIX C. REPRODUCIBILITY AND INTERPRETATION CHECKLIST

Table C1. Reproducibility and interpretation checklist.

Stage	Required practice
City matching	Normalise names, inspect duplicates, and confirm geography.
Index construction	Standardise components and test alternative weights.
Rank outcomes	Reverse ranks, while retaining rank-sensitive correlation.
Regression	Use robust errors and interpret adjusted associations.
Missingness	Use separate validation samples when this preserves information.
Causality	Avoid causal wording without temporal identification.
Policy interpretation	Target the weakest ecosystem component.
Heritage data	Allocate sites only with defensible city boundaries.