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Assessing Innovation System and Creative Output Performance in Oman: A Time-Series TOPSIS Approach

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Abstract. This study develops a time-series multi-criteria framework to assess Oman's annual performance in its innovation system and creative output. Rather than estimating direct causal relationships, the paper applies the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to compare Oman's yearly profiles according to their proximity to an ideal performance configuration. The analysis uses annual Oman data reported in the Global Innovation Index country-profile architecture and evaluates six annual observations from 2020 to 2025. The baseline model incorporates seven criteria: institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs. By treating years as the decision alternatives, the study provides a structured temporal benchmarking exercise rather than a cross-country comparison. The results show that 2022 records the strongest overall annual profile, followed by 2025 and 2023, while 2020 and 2021 remain the weakest years. A Monte Carlo sensitivity analysis indicates that the broad ranking pattern is moderately stable, although middle positions are more sensitive to alternative weighting structures than the leading year. The study contributes a transparent decision-analytics framework for evaluating annual performance of Oman's innovation system and creative output and offers policy-relevant evidence that Oman's progress depends on balanced improvement across institutional quality, research capability, market conditions, business sophistication, and output conversion.

Keywords: innovation systems; creative outputs; TOPSIS; time-series benchmarking; multi-criteria decision analysis; Global Innovation Index; Oman

1. Introduction

Innovation and creativity have become central themes in contemporary development policy, especially in economies seeking to diversify beyond traditional growth models and build more knowledge-intensive development pathways, as creative-economy and knowledge-economy strategies are increasingly linked to diversification, capability formation, and broader development transformation (United Nations Conference on Trade and Development, 2024; Britto, 2016; Dubina et al., 2011). In the innovation literature, innovation is generally understood as the implementation of a new or improved product or process, whereas the creative-economy literature emphasises the generation of novel ideas, symbolic content, design capabilities, and intellectual assets that may later be translated into economic value (OECD/Eurostat, 2018; Britto, 2016). This distinction matters because economies do not innovate merely by producing ideas. They innovate when novelty is organised, financed, diffused, and applied in ways that are economically and socially consequential.

For Oman, this issue is especially important. Like many resource-dependent and structurally transforming economies, Oman faces the challenge of strengthening innovation capacity, broadening economic activity, and improving its sustainability profile at the same time. In this context, creativity, innovation, and structural transition should not be treated as isolated policy domains (Oman Vision 2040 Implementation Follow-up Unit, 2023; International Monetary Fund, 2022; Al-Busaidi, 2020). Research on the creative economy increasingly treats it as a development-oriented field rooted in intellectual, social, cultural, and institutional capital rather than as a narrowly cultural sphere (Ausat et al., 2023), while comparative work shows that the creative economy can function as a factor of broader economic development when linked to capability formation, policy, innovation systems, and sustainability-oriented transformation in developing economies (Lopez-Leyva & Guzmán-Solano, 2021; "Creative Economy and Sustainable Development in Developing Economies," 2024). Research on the creative economy and universities further suggests that spillovers between higher education, entrepreneurship, and creative activities are relevant to the conversion of symbolic and knowledge-based assets into wider development outcomes (Lazzaro, 2021). In the Omani setting, this broader developmental logic is consistent with recent evidence linking governance quality to growth performance and sustainability-related economic outcomes (Al-Saadi & Khudari, 2024; Al-Hajri & Khudari, 2025).

Despite this relevance, the literature remains fragmented in three main respects. First, many studies discuss the creative economy as a source of growth without clearly explaining how creative outputs connect to economy-wide innovation performance over time. Second, empirical work often stops at descriptive association and does not adequately distinguish substantive linkage from shared underlying conditions such as human capital, institutional quality, digital infrastructure, or measurement overlap. Third, sustainability-oriented discussions often assume that creativity and innovation are inherently developmental, even though their actual value depends on the institutional and ecological conditions in which they operate.

This study addresses these issues by developing a time-series comparative assessment of Oman. Rather than attempting to test reciprocal causality directly, the paper uses TOPSIS to evaluate how innovation-system performance, creative outputs, and enabling conditions co-occur across annual observations of the Omani economy. The contribution is therefore methodological and policy-oriented. Instead of ranking countries, the study ranks years, allowing the analysis to identify stronger and weaker annual profiles in Oman's development trajectory. This methodological choice is consistent with the broad use of TOPSIS in applied multi-criteria decision problems (Behzadian et al., 2012), with prior entropy-based TOPSIS studies of innovation-performance comparison (Kaynak et al., 2017), and with TOPSIS-based decision-support applications in the valuation of creative activities (Madudová & Palenčíková, 2019).

The core problem addressed in this paper is the absence of a sufficiently integrated and operational framework for comparing Oman's innovation and creative output profile across time. Existing studies

show that these dimensions matter for development, yet they are often discussed in separate analytical traditions. Innovation is usually framed in terms of productivity, technological upgrading, and national innovation systems, whereas creativity is more often located within cultural industries, symbolic production, and the creative economy. Sustainability, meanwhile, is often introduced as a broader contextual concern without being translated into a transparent comparative framework in the current model.

The study pursues three objectives. First, it clarifies the conceptual relationship among innovation, creativity, and the creative economy in the Omani context. Second, it develops a transparent multi-criteria framework for comparing Oman's annual profiles using TOPSIS. Third, it interprets the resulting year-based ranking in a policy-relevant way by identifying which criterion blocks appear to strengthen or weaken Oman's trajectory over time.

The remainder of the article is organised as follows. Section 2 reviews the literature and presents the conceptual framework for the Oman case. Section 3 explains the time-series TOPSIS methodology, variables, and data sources. Section 4 reports the annual ranking results, their robustness, and their policy interpretation. Section 5 concludes the paper and outlines directions for future research.

2. Literature Review

2.1. Conceptual foundations of innovation, creativity, and the creative economy in the Oman context

Innovation and creativity are closely related, but they are not identical. In the OECD/Eurostat framework, innovation refers to a new or improved product or process that differs significantly from previous offerings and has been implemented or made available to users. Creativity, by contrast, refers to the generation of original and useful ideas, symbolic forms, and novel combinations that may later be translated into measurable outputs or innovations. Preserving this distinction is important in the Omani context because it prevents creativity from being reduced to culture alone and innovation from being reduced to technology alone (OECD/Eurostat, 2018).

The creative economy is increasingly understood as a knowledge-based, development-oriented domain in which value creation depends on ideas, intellectual property, design, symbolic assets, technology, and human capabilities (United Nations Conference on Trade and Development, 2024). Comparative work shows that the creative economy is not merely a cultural appendage but can be treated as a factor in broader economic development when linked to innovation, institutions, and strategic policy support (Lopez-Leyva & Guzmán-Solano, 2021). Related evidence also emphasises that the creative economy depends on forms of intellectual, social, cultural, and institutional capital that shape its wider developmental role (Ausat et al., 2023). This broader perspective is particularly relevant for Oman because long-run economic transformation requires more than sectoral expansion; it requires strengthening capabilities to support innovation, knowledge formation, and more sustainable structural change.

Recent evidence from Oman is broadly consistent with this logic. Governance quality has been shown to matter for economic performance in Oman, while environmental and green-productivity studies suggest that sustainability-related outcomes are shaped by wider institutional, competitiveness, and investment conditions rather than by isolated environmental variables alone (Al-Saadi & Khudari, 2024; Al-Hajri & Khudari, 2025; Khudari et al., 2026a). In the present study, however, the broader creative-economy domain is operationalised only partially because the active empirical model is a baseline specification built around annual innovation-system indicators, creative outputs, and one sustainability-related structural dimension.

This measurement-oriented perspective is also supported by attempts to construct composite indices linking innovation and institutions within a broader creative-economy framework, suggesting that the creative economy is appropriately studied through multidimensional indicators rather than through one isolated cultural or technological metric (Żelazny & Pietrucha, 2017).

2.2. Innovation and economic growth: relatively stronger evidence of mutual reinforcement

The empirical literature provides stronger support for a reciprocal relationship between innovation and economic growth than for creativity alone. In developing-country settings, technological innovation indicators such as research activity, patents, innovation inputs, and related capability variables have been shown to support economic growth, and some studies report long-run bidirectional causality between innovation and growth. Mohamed et al. (2022), for example, explicitly argue that there is a long-term causal relationship in both directions between technological innovation and economic growth in the developing economies they study. Roger et al. (2022) similarly examine Sub-Saharan Africa and conclude that ICT development and innovation diffusion support sustainable growth within a causal framework that allows for feedback relationships.

Comparable evidence appears in studies using broader composite innovation measures. Dempere et al. (2023) show that the Global Innovation Index and its pillars are positively associated with GDP and other macroeconomic outcomes in a global sample, while Vasin and Timokhina (2024) find that innovation-related factors remain relevant for socioeconomic development even under crisis conditions. Taken together, these studies support a relatively strong conclusion: innovation is not merely an outcome of economic advancement, but also an important driver of it, and the relationship may be mutually reinforcing in developing and emerging-economy contexts (Mohamed et al., 2022; Roger et al., 2022; Dempere et al., 2023; Vasin & Timokhina, 2024).

This distinction matters for the present study because the Oman model relies heavily on innovation-system pillars derived from the Global Innovation Index architecture. The literature, therefore, provides a stronger foundation for interpreting these pillars as development-relevant and potentially mutually reinforcing with broader economic performance over time than it does for making the same claim about creativity alone.

2.3. Creativity, creative outputs, and development: supportive but less conclusive evidence

The evidence base for creativity is more qualified. A growing literature suggests that creative industries, creative employment, symbolic production, and culture-based sectors contribute positively to development, employment, urban vitality, and sustainability outcomes. However, this literature usually does not establish strict two-way causality between a standalone creativity index and economic growth. Instead, creativity is more often examined through sectoral evidence, human-capital evidence, or composite frameworks that combine creativity with innovation, research capability, and institutional conditions. This is also consistent with more recent work showing that innovation ability can be examined in relation to cultural and creative talent formation, which reinforces the view that creativity and innovation capability are analytically connected rather than fully separable domains (Wang & Ma, 2023).

Štreimikienė and Kačerauskas (2020), for example, link the creative economy to sustainable development outcomes and emphasise the developmental value of creative sectors, but they do not frame the relationship as a strict reciprocal macro-causality test between a creativity index and growth. Rossi et al. (2024) likewise propose a complex territorial indicator that combines innovation, researchers, and creativity, reinforcing the idea that creativity is often treated as part of a broader capability system rather than as an autonomous engine whose feedback relationship with growth has already been rigorously demonstrated. More recent work also continues to link creative-class structures to sustainability outcomes, reinforcing the argument that creativity should be understood within a broader developmental and territorial framework rather than as an isolated cultural indicator (Sokóła et al., 2025). In this sense, creativity appears in the literature as a meaningful developmental dimension, but one whose macro-level relationship with growth is more indirect, embedded, and context-dependent than the innovation-growth relationship.

This distinction is analytically important for Oman. Creative outputs are clearly relevant to a

knowledge-based development strategy, but the current literature does not justify treating them as if they have the same established reciprocal macroeconomic status as innovation indicators. They are better interpreted as indicators of symbolic, intangible, and knowledge-based output performance that evolve alongside wider enabling conditions. This interpretation is also consistent with evidence that universities can act as spillover channels connecting entrepreneurship, knowledge creation, and the creative economy, which is relevant to policy debates on commercialisation and innovation ecosystems in emerging economies (Lazzaro, 2021).

2.4. Shared developmental foundations and sustainability-related context

A stronger framework must therefore avoid overstating direct causality. A positive relationship between creativity and innovation may arise not because one directly causes the other, but because both depend on shared developmental foundations, including human capital, institutional quality, research capability, digital infrastructure, and business-system depth. In Oman, these foundations are especially important because the country's long-run development strategy depends on capability building, institutional effectiveness, and structural transition rather than on one-dimensional expansion alone. Broader comparative evidence also suggests that political stability and macroeconomic conditions shape investment attractiveness, thereby conditioning the broader innovation and capability environment in which annual profiles evolve (Khudari et al., 2023). Human capital is especially relevant in this context because creative-economy and innovation performance depend not only on outputs, but also on the development and preservation of the skills base that underpins knowledge-intensive activity (Kuznetsova et al., 2022).

Sustainability remains an important contextual consideration in interpreting innovation and creative-output performance. Creativity and innovation are not automatically aligned with sustainable development, and their broader developmental value depends on whether they are embedded in systems that are institutionally credible, capability-enhancing, and responsive to long-run environmental and structural challenges. This caution is especially relevant in Oman, where recent evidence on carbon emissions, financial development, and economic growth, as well as on the roles of competitiveness and foreign direct investment in green productivity, points to a more complex sustainability transition than any single indicator can capture (Al-Hajri & Khudari, 2025; Khudari et al., 2026a). In the present study, however, sustainability is treated as a contextual background rather than as a directly operationalised TOPSIS criterion.

This broader logic is also consistent with recent Oman-related evidence from the maritime logistics sector, where sustainable performance is shown to depend on the interaction among technological, organisational, and environmental conditions, as well as on knowledge transfer, rather than on a single isolated driver (Al-Ajmi et al., 2026). The implication for the present study is that annual innovation and creative-output performance should be interpreted within a wider configuration of capability and sustainability conditions, not as self-contained outcomes.

2.5. Conceptual framework and analytical expectations for the Oman time-series analysis

The framework developed in this study treats innovation-system performance, creative outputs, and shared developmental foundations as three mutually informative blocks that together shape Oman's annual profile. Innovation-system performance captures institutions, research capability, market sophistication, business sophistication, and knowledge-related output conditions. Creative outputs capture the extent to which symbolic and intangible capacities are translated into measurable annual output performance. Shared developmental foundations refer to the broader capability environment within which these outcomes are generated. Sustainability remains part of the broader interpretive context of the study, but it is not included as a directly operationalized criterion in the present TOPSIS model.

Because the empirical design is comparative rather than causal, the framework is expressed through

analytical expectations rather than formal causal hypotheses. This choice is methodologically appropriate. The literature offers relatively strong support for the view that innovation and growth may reinforce one another, but much weaker support for claiming an equivalent bidirectional relationship between standalone creativity indicators and growth. Accordingly, the present study does not attempt to estimate whether creativity causes innovation, whether innovation causes creativity, or whether either directly causes growth in a strict econometric sense. Instead, it evaluates how these dimensions co-occur across Oman's annual profiles.

Three analytical expectations follow from this framework. First, years in which Oman records stronger performance across innovation-system and creative-output criteria are expected to show higher TOPSIS closeness coefficients. Second, balanced performance across the relevant criterion blocks is expected to matter more than isolated strength in a single pillar. Third, weaker annual profiles are expected to reflect cumulative deficits across several dimensions rather than one isolated shortcoming. In this way, the conceptual framework remains aligned with both the available literature and the study's methodological design: the paper evaluates multidimensional configurations of annual performance rather than causal reciprocity.

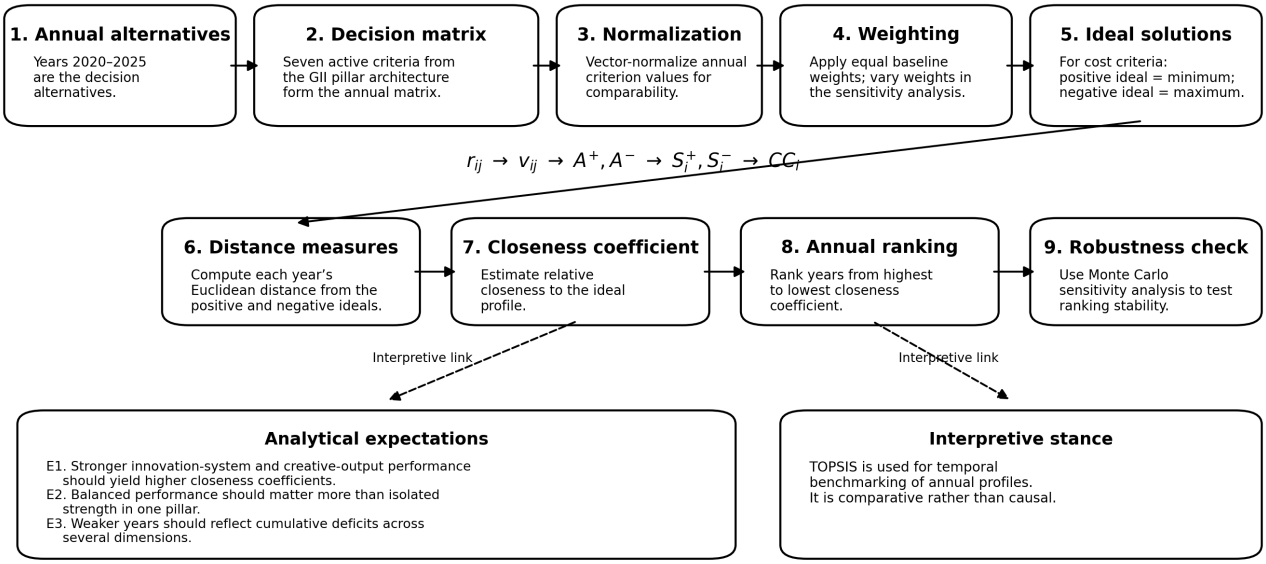

Fig.1: Conceptual framework of TOPSIS procedures and analytical expectations

3. Methodology

3.1. Research design and rationale

This study applies the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to evaluate Oman's annual performance in innovation-system conditions and creative outputs. Unlike a cross-country design, the present model treats years as the alternatives. This makes the method suitable for temporal benchmarking: the purpose is not to compare Oman with other countries, but to compare Oman with itself across time. TOPSIS is an appropriate choice because it is one of the most widely used multi-criteria decision analysis (MCDA) methods in applied decision problems and has been extensively used across diverse evaluation settings (Behzadian et al., 2012).

The time-series design is intentional. TOPSIS is used here to generate a structured comparison of

annual profiles rather than to estimate causality. The method is therefore used to examine how innovation-system conditions, creative outputs, and enabling foundations co-occur across successive years in Oman's development trajectory. This choice is consistent with prior work applying entropy-based TOPSIS to innovation-performance comparison (Kaynak et al., 2017) and with research using TOPSIS-based decision-support approaches to evaluate creative activities in multidimensional settings (Madudová & Palenčíková, 2019). Recent sustainability-oriented applications also demonstrate the continued relevance of MCDA frameworks for complex evaluation problems in which multiple environmental, institutional, and performance dimensions must be assessed jointly (Li et al., 2024).

3.2. Alternatives and time horizon

The model's alternatives are annual observations of Oman. In the current baseline specification, the analysis covers 2020–2025, with each year treated as one alternative in the decision matrix. The TOPSIS procedure therefore compares Oman in 2020, 2021, 2022, 2023, 2024, and 2025. This allows the study to assess whether Oman's multidimensional profile has moved closer to or farther from an ideal innovation–creative output configuration across time.

3.3. Variables and data sources

The baseline Oman model is built from official Oman country-profile data reported in the Global Innovation Index source architecture. In the current operational specification, the active criteria are seven GII pillar-rank variables: institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs. The annual Oman profile ranks are drawn from the World Intellectual Property Organisation's (WIPO) Global Innovation Index country-profile publications for Oman and from related linked-source architecture (WIPO, 2024; WIPO, 2025).

Table 1 reports the operational variables used in the TOPSIS model and identifies the official data source for each criterion. The model evaluates Oman's annual innovation-system and creative-output profile using seven GII pillar-rank indicators reported in the WIPO country-profile architecture.

Table 1. Operational variables used in the TOPSIS model and the source of data

Variable	Symbol	Operational definition in this study	Role in TOPSIS model	Criterion type	Direction of preferable performance	Main source of data
Institutions	INST	Annual Oman rank for the GII institutions pillar, reflecting the institutional and regulatory environment supporting innovation activity	Active criterion	Cost	Lower rank = stronger performance	World Intellectual Property Organization (WIPO), *Oman ranking in the Global Innovation Index 2024* and *Oman ranking in the Global Innovation Index 2025*
Human capital and research	HCR	Annual Oman rank for the GII human capital and research pillar, capturing education, tertiary capability, and research-related innovation inputs	Active criterion	Cost	Lower rank = stronger performance	WIPO Oman GII country-profile source architecture
Infrastructure	INFRA	Annual Oman rank for the GII infrastructure pillar, reflecting ICT, general infrastructure, and ecological sustainability-	Active criterion	Cost	Lower rank = stronger performance	WIPO Oman GII country-profile source architecture

		related enabling conditions within the GII framework				
Market sophistication	MKT	Annual Oman rank for the GII market sophistication pillar, reflecting credit, investment, trade, competition, and market-related support for innovation	Active criterion	Cost	Lower rank = stronger performance	WIPO Oman GII country-profile source architecture
Business sophistication	BUS	Annual Oman rank for the GII business sophistication pillar, reflecting knowledge workers, innovation linkages, and knowledge-absorption conditions	Active criterion	Cost	Lower rank = stronger performance	WIPO Oman GII country-profile source architecture
Knowledge and technology outputs	KTO	Annual Oman rank for the GII knowledge and technology outputs pillar, reflecting codified innovation-related output performance	Active criterion	Cost	Lower rank = stronger performance	WIPO Oman GII country-profile source architecture
Creative outputs	CO	Annual Oman rank for the GII creative outputs pillar, reflecting symbolic, intangible, and creative-economy-related annual output performance	Active criterion	Cost	Lower rank = stronger performance	WIPO Oman GII country-profile source architecture

These variables are used because they are available consistently across the annual Oman profiles currently assembled and provide a comparable basis for temporal evaluation. The present model therefore evaluates a baseline Oman profile rather than a fully expanded creative-economy or sustainability scorecard. Future extensions should incorporate additional official time-series indicators, such as research and development expenditure, ICT access, and broader environmental measures, to deepen the framework's empirical coverage.

Table 2. Annual Oman baseline input data (GII pillar ranks; lower values indicate stronger positions)

Year	GII overall rank	Institutions	Human capital & research	Infrastructure	Market sophistication	Business sophistication	Knowledge & technology outputs	Creative outputs
2020	84	70	43	56	104	95	124	94
2021	76	71	45	56	84	94	107	71
2022	79	57	40	56	71	97	94	80
2023	69	62	52	61	74	95	75	79
2024	74	43	66	63	73	86	87	82
2025	69	40	73	55	70	63	91	85

Note. The annual values are official Oman profile ranks reported in the Global Innovation Index country-profile architecture for Oman (WIPO, 2024; WIPO, 2025). Because these are rank positions, lower values indicate better relative performance within the relevant GII edition.

3.4. Weighting strategy, TOPSIS procedure, and robustness checks

The baseline Oman model assigns equal weights across the seven active criteria. This is retained deliberately as a transparent starting point rather than as a claim that all criteria are substantively identical in importance. Equal weighting is appropriate at this stage because the objective is to provide a first temporal benchmarking exercise, and the conceptual framework does not yet justify a defensible ex ante hierarchy across the selected criteria.

TOPSIS is used to compare Oman's annual observations according to their relative proximity to an ideal profile and their distance from an anti-ideal profile. Let x_{ij} denote the observed value of year i on criterion j, where i = 1, 2, …, m and j = 1, 2, …, n. The decision matrix is first normalised using vector normalisation; the normalised matrix is then multiplied by the criterion weights to obtain the weighted normalised matrix. Because all criteria in the current Oman baseline model are treated as cost criteria, the positive ideal solution is defined as the minimum value of each criterion across years, and the negative ideal solution as the maximum value. The Euclidean distances of each year from the positive and negative ideal solutions are then computed, followed by the relative closeness coefficient. Years are ranked in descending order of the closeness coefficient, with higher-ranked years interpreted as stronger annual profiles.

To assess robustness, the study supplements the equal-weight baseline with a Monte Carlo sensitivity test in which 500 random weight vectors are generated from a symmetric Dirichlet distribution subject to the constraint that the weights sum to 1.00. For each draw, the weighted normalised matrix, the ideal and anti-ideal solutions, the closeness coefficients, and the year ranking are recalculated. This procedure does not estimate sampling error in the conventional econometric sense. Instead, it evaluates whether the ranking structure remains broadly stable under plausible variation in the normative weighting scheme.

The TOPSIS procedure can be summarised as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = 1,2,\dots,m, j = 1,2,\dots,n$$

$$v_{ij} = w_j r_{ij}$$

$$A^+ = \{v_1^+, v_2^+, \dots, v_n^+\}, v_j^+ = \min_i \left(v_{ij}\right) \text{for all active cost criteria}$$

$$A^- = \{v_1^-, v_2^-, \dots, v_n^-\}, v_j^- = \max_i \left(v_{ij}\right) \text{for all active cost criteria}$$

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2}$$

$$CC_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

4. Results and Discussion

4.1. Baseline TOPSIS ranking of Oman across years

Table 3 reports the baseline ranking for Oman's annual profiles over 2020–2025. The results show that 2022 is the strongest year in the current baseline model, with a closeness coefficient of 0.6174. It is followed by 2025 (0.5718), 2023 (0.5697), and 2024 (0.5620). The two weakest years are 2021 (0.4751) and 2020 (0.3719), with 2020 ranking last.

The ranking indicates that Oman's relative profile improved after 2020 and reached its strongest position in 2022, before remaining comparatively strong but more compressed in 2023–2025. In practical terms, the results suggest that Oman's multidimensional innovation and creative-output profile did not follow a simple monotonic trend. Instead, it improved unevenly across years, with the strongest annual profile reflecting broad balance across the selected criteria rather than extreme performance on one pillar alone.

Table 3. Baseline TOPSIS ranking of Oman across years

Year	Closeness coefficient	Rank
2022	0.6174	1
2025	0.5718	2
2023	0.5697	3
2024	0.5620	4
2021	0.4751	5
2020	0.3719	6

Note. Higher closeness coefficients indicate years that lie nearer to the ideal annual profile and farther from the anti-ideal profile.

4.2. Interpretation of annual ranking patterns

The annual ordering is substantively consistent with the underlying pillar-rank profiles. The strongest year, 2022, combines Oman's best human capital and research rank (40) with a comparatively strong institutions rank (57), a relatively improved market sophistication rank (71), and a less adverse knowledge and technology outputs rank (94) than in 2020 and 2021. Although 2022 does not dominate every pillar, it appears to offer the most balanced overall profile among the six annual observations.

The second-ranked year, 2025, presents a different pattern. It records Oman's strongest institutions rank (40), best infrastructure rank (55), best market sophistication rank (70), and best business sophistication rank (63), but this gain is partially offset by a weaker human capital and research rank (73). This helps explain why 2025 remains very strong overall but does not surpass 2022 in the baseline TOPSIS ordering.

The two intermediate years, 2023 and 2024, are relatively close to one another, with closeness coefficients of 0.5697 and 0.5620, respectively. The 2023 profile benefits especially from a much stronger knowledge and technology outputs rank (75) than the preceding years, while 2024 benefits from notable improvement in institutions (43) and business sophistication (86), but is held back by a weaker human capital and research position (66). These two years, therefore, represent moderately strong but internally mixed profiles.

The weakest years are 2021 and especially 2020. In 2020, Oman recorded its weakest market sophistication rank (104), a weak business sophistication rank (95), the weakest knowledge and technology outputs rank (124), and a weak creative outputs rank (94). The 2021 profile improves materially, especially in market sophistication and creative outputs, but still remains below the later years in the overall ordering. Taken together, these results suggest that weaker annual profiles are cumulative rather than singular: lower-ranked years tend to show simultaneous weakness across several pillars rather than one isolated deficiency.

4.3. Sensitivity analysis

A sensitivity analysis was conducted to assess whether the reported annual ranking is mainly an artifact of the equal-weight assumption or whether it remains broadly stable under admissible alternative weighting structures. For this purpose, 500 alternative weight vectors were generated from a symmetric Dirichlet distribution over the seven active criteria, with each simulated vector constrained to sum to 1.00. For each draw, the weighted normalised matrix was recalculated, the positive and negative ideal solutions were re-derived, new closeness coefficients were computed, and the full ranking of the six-year sample was regenerated.

The results indicate moderate robustness, as shown in Table 4. The mean Spearman rank correlation between the baseline ordering and the 500 simulated rankings is 0.519, with a median of 0.600. This is noticeably lower than in large cross-country applications, which is expected because a six-alternative annual ranking is inherently more sensitive to weight changes than a much larger cross-sectional sample. Even so, some structural patterns remain stable. The top-ranked baseline year, 2022, remains in the top three in 79.4% of the simulations and ranks first in 36.2% of runs. The second-ranked baseline year, 2025, ranks first in 40.8% of runs and remains in the top three in 61.8% of simulations. At the lower end, 2020 remains in the bottom two in 76.2% of runs, while 2021 remains in the bottom two in 59.2% of runs.

These results suggest that the broad distinction between stronger and weaker annual profiles is more reliable than the exact ordering of the middle positions. In other words, the analysis supports a tier-based interpretation of Oman's annual trajectory rather than an absolutist reading of every individual rank. The evidence indicates that 2022 and 2025 form the strongest band, 2023 and 2024 form an intermediate band, and 2020–2021 form the weakest band, even though the order within the upper and middle groups may vary under alternative weights.

Table 4. Monte Carlo sensitivity summary for Oman across years

Year	Top 1 freq. (%)	Top 3 freq. (%)	Bottom 2 freq. (%)	Min rank	Max rank	Mean rank	Rank SD
2022	36.2	79.4	1.8	1	5	2.35	1.20
2025	40.8	61.8	28.6	1	6	2.93	1.97
2023	12.6	50.4	7.0	1	6	3.16	1.19
2024	6.8	61.0	27.2	1	6	3.22	1.49
2021	3.6	35.0	59.2	1	6	4.02	1.31
2020	0.0	12.4	76.2	2	6	5.31	1.19

Note. Frequencies are based on 500 simulations of Dirichlet-distributed weights. The top 1 frequency shows how often a year ranked first; the top 3 frequency shows how often it remained within the top three; the bottom 2 frequency shows how often it remained within the bottom two annual positions.

4.4. Policy implications for Oman

The findings carry several policy implications. First, Oman's strongest annual profiles are associated with broad balance rather than isolated improvement. This suggests that reform efforts should continue to combine institutional strengthening, human-capital development, research capabilities, market sophistication, and business-system depth rather than relying on a single policy lever. This emphasis on coordinated capability building is consistent with evidence that governance quality and institutional effectiveness are integral to growth performance in Oman (Al-Saadi & Khudari, 2024).

Second, the annual ranking highlights the importance of conversion. Years with relatively stronger enabling conditions do not always achieve equally strong creative-output or knowledge-output positions. This implies that policy should focus not only on inputs and framework conditions, but also on the mechanisms that translate them into measurable outputs. In practice, this points to commercialisation pathways, stronger university-industry linkages, support for knowledge-intensive firms, and institutions that can connect symbolic and creative activity to wider innovation ecosystems. This emphasis is consistent with work linking university entrepreneurship and creative-economy spillovers (Lazzaro, 2021) and with broader evidence that creative-economy performance depends on institutional and social capital rather than on symbolic production alone (Ausat et al., 2023). In Oman, this emphasis on knowledge transfer is also consistent with recent TOE-based evidence showing that sustainable supplier performance is strengthened when technology, organisational readiness, environmental conditions, and knowledge transfer operate together rather than separately (Al-Ajmi et al., 2026).

Third, the Omani case suggests that innovation upgrading should be interpreted within a broader sustainability-aware policy framework. The annual profile approach does not establish causality, but it does show that development quality is better assessed when innovation-related conditions are

interpreted in relation to wider environmental and structural challenges rather than in isolation. This is consistent with recent Oman-focused evidence suggesting that competitiveness, foreign direct investment, and green productivity are linked in ways that require coordinated rather than fragmented policy responses (Khudari et al., 2026a). It is also compatible with Oman-specific evidence that environmental performance is tied to broader growth and financial-development dynamics rather than to isolated environmental policy alone (Al-Hajri & Khudari, 2025).

4.5. Limitations and future research

The present study has several limitations. First, the baseline model currently relies on seven GII pillar-rank criteria and does not yet incorporate additional official time-series variables such as research and development expenditure, ICT access, or broader energy and environmental indicators. Second, year-on-year GII comparisons must be interpreted with caution because data availability and framework changes across editions may affect comparability. Third, equal weighting is transparent and defensible for a first baseline model, but it remains a normative choice. Future work should compare the current results against entropy-based, CRITIC-based, or hybrid weighting schemes. It should also consider whether Oman's innovation and sustainability trajectory contains structural breaks or regime changes, since temporal patterns in service-oriented economies may be misread when instability is ignored (Khudari et al., 2026b).

Most importantly, TOPSIS is a ranking method rather than a causal model. It can identify stronger and weaker annual profiles, but it cannot by itself establish whether creativity causes innovation, whether innovation reinforces creativity, or whether both are jointly shaped by deeper structural conditions. These questions should be addressed in future research using complementary inferential approaches once a sufficiently rich Oman time-series dataset has been assembled.

5. Conclusion

This paper set out to provide a comparative time-series assessment of Oman's innovation-system performance and creative outputs using TOPSIS. In response to conceptual and methodological ambiguities in the wider literature, the study aligns its theory, method, and claims by treating TOPSIS as a temporal benchmarking tool rather than as a test of causal interdependence.

The results show that 2022 has the strongest annual profile in the current baseline model, followed by 2025 and 2023, whereas 2020 and 2021 are the weakest years in relative terms. More broadly, the findings suggest that stronger annual profiles are associated with balance across multiple dimensions rather than headline strength in a single pillar. This matters for policy because it implies that Oman's longer-run progress depends on coordinated improvements across institutions, research capabilities, business sophistication, infrastructure, and creative outputs rather than on isolated gains.

The study contributes a transparent baseline framework for comparing Oman's annual profiles and offers a policy-relevant interpretation of how innovation conditions and creative performance evolve together over time. Future research should extend the model by incorporating additional official time-series indicators, broader environmental measures, and complementary inferential methods that can test causal relationships more directly.

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