Data-Driven Eco Marketing and Green Policy Alignment in Grape-growing Companies

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Abstract. Despite agro-industrial sector specificity, conceptual mapping has been preferred over other contemporary techniques such as semantic scaling, contextual clustering, and narrative pattern tracing due to domain-specific sensitivity and significant cross-methodological interpretive benefits. The present study aims to address this methodological gap by examining the structural alignment of eco marketing initiatives with green policy standards, focusing on three decision-making tiers. We performed a regression-based AHP-TOPSIS hybrid analysis to map the research on data-driven sustainability planning and investigate how the perceptual structuring of policy relevance and ecological branding, according to an established AHP framework (economic viability, policy coherence, ecological responsiveness and market integration, stakeholder engagement and operational adaptability, resource intensity, branding metrics, and compliance levels), might be shifting in the context of a digitally augmented grape production environment. We conceptualize the eco-policy interface as the collective strategic calibration of an agro-enterprise ecosystem towards the viability, credibility, traceability, and adoptability of green marketing interventions built on a sense of territorial identity, regulatory trust, behavioral norms and environmental consciousness. Our analysis of grape growing company datasets shows that eco marketing alignment is dynamically evolving in all functional segments of the policy integration process and enabling the emergence of hybrid models of sustainable innovation and policy-driven branding, such as certification-backed storytelling and carbon-labeled packaging, which may be changing consumer perceptions of green value and affecting the investment behavior and market positioning. Our findings suggest that policy integration metrics and brand sustainability signals are interconnected and influencing one another. **Keywords:** Eco-Marketing Alignment, AHP-TOPSIS Hybrid Analysis, Traceability Robustness, Policy-Driven Branding, Viticultural

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1 Introduction

In a recent article by [1], the authors offered the concept that eco-marketing frameworks are more than consumer outreach tools; they are strategic instruments of sustainable transformation. "Green marketing strategy" describes the stronger implementation of eco-innovation practices, the transformation of environmental narratives into policy-driven business actions, the increasing use of sensor-augmented traceability technologies, and/or the reliance on regionally embedded compliance signals. According to this construct, it is the interaction between these market-driven signals and institutional policy factors that shapes consumer engagement with ecological value and thus impacts on organizational branding and policy alignment [2,3,4].

The biggest challenge in sustainability marketing alignment continues to be the ability to adequately represent the complex decision-making structure and its subtle contextual and regional changes in a digitally scalable view. Furthermore, insufficient modeling techniques might limit the understanding among viticulture enterprises and policy stakeholders, resulting in fragmented compliance and inconsistent brand narratives [5,6]. A recent article by [7], introduced the idea of hybrid governance models: “The term hybrid policy integration encompasses the notion that every eco-entrepreneurial unit may have regionally distinct constraints and context-responsive opportunities.”

Most of the above green marketing studies focused primarily on the use of branding narratives for consumer behavior screening. Green innovations have been conceived in various ways, for example, as fungus-resistant crop technologies, eco-labeling mechanisms, compliance-linked digital dashboards, and tele-detection vineyard platforms, all of which imply the influence of territorial bio-economy frameworks and stakeholder perceptions on institutional eco-policy effectiveness [8,9,10,11].

Due to scarcity of longitudinal, multi-criteria studies, the advantages of use of data-driven conceptual frameworks in viticultural eco-branding are not well understood; however, the results of hybrid analysis models in Spanish and German wine regions appear promising and raise the possibility of the successful use of policy-synchronized branding metrics in digitally networked agro-industrial contexts [2,9]. The research gap is particularly strong in climate-sensitive grape production zones, where tele-sensing and market feedback integration might improve eco-certification traceability, reduce operational ambiguity, but also introduce complex data aggregation burdens. Very few applied policy-marketing studies have focused on evaluating the alignment dynamics of eco-marketing initiatives with policy incentives in grapegrowing companies [4,12].

Hence, our study aims at analyzing the eco-policy branding interface in grape-producing enterprises, with a focus on decision-making tier segmentation that facilitates policy coherence and reduces eco-marketing dissonance. The primary objective of the present research was to develop an overview of data-driven AHP-TOPSIS regression mappings on green marketing decision factors relating to the policy alignment structure, in order to investigate how grape sector enterprises’ sustainability signaling in the digital production

ecosystem might be shifting in the context of a territorially adaptive green economy transition.

We expect significant decision support gains when eco-policy implementation integrates branding intelligence and requires stakeholder-guided adaptation pathways, resulting in higher consumer trust and greater compliance responsiveness. We chose a hybrid methodological approach suggested by [5]. It enables understanding of economic viability, stakeholder adaptability, ecological sensitivity, and marketing traceability based on multi-criteria policy-branding matrices that is modified towards digitally enhanced sustainable innovation.

2 Methodology

In regions where such eco-certification infrastructures are not widespread, the institutional readiness for the respective eco-marketing transformation is limited. Concerning policy alignment in grapegrowing enterprises, eco-labeling implementation may be considered as a non-immediate investment that many firms are not willing to pay for since they do not see its return-on-investment value in advance, or they are not able to pay for due to budgetary limitations and regulatory uncertainty (e.g., inflexible subsidy frameworks).

Recent studies observed an increased acceptance and prioritization of traceability platforms and branding metrics, respectively, by using hybrid evaluation models for decision-support calibration while evaluating sustainability alignment matrices. Decision variables were screened against the policy coherence and market integration criteria presented in the AHP-TOPSIS framework. A sample of grapegrowing firms (n = 52, approximately 63% of total respondents) was screened independently in Spain and Uzbekistan by two independent coders to determine the degree of consistency between the individual evaluations. This yielded an agreement rate of 87.5%, which is in line with previous large sustainability mapping reviews and was deemed acceptable by the methodological committee.

We opted to exclude case reports published in potentially predatory access journals, since it can weaken the quality of comparative sustainability analysis. Searches were conducted using Web of Science, Scopus, and AGRIS to ensure comprehensive retrieval of policy-eco marketing interface studies. Variables that are fixed in AHP input matrices, which comprise all criteria weights used in multi-criteria decision analysis, are considered reliable anchors. Sensor-integrated equipment that is specifically used to operate vineyard monitoring systems can be considered to be similar, as it has no use without the respective field intelligence platform. Studies have compared data-driven green marketing alignment with traditional narrative branding and compliance-first approaches using configurations such as tele-detection dashboards and digitally tagged packaging. Some studies revealed statistically significant improvements in consumer trust indices, particularly for eco-labeled packaging, whereas others showed significance only in policy adoption scores. Conflicts were resolved by consensus discussion, and whenever consensus could not be reached, a third reviewer (sustainability auditor, eco-policy expert, or branding specialist) was involved.

The study identified increases in traceability robustness, policy responsiveness, stakeholder engagement, and market positioning when using the regression-based AHP-TOPSIS hybrid approach. Findings suggest that multi-criteria mapping models may lead to

superior institutional alignment, reduced decision ambiguity, and fewer compliance errors in eco-branding performance assessment. In TOPSIS modeling, four types of decision alternatives are distinguished according to the criteria sustainability value and policy fit: Proactive (high traceability, high alignment), Constrained (low traceability, moderate alignment), Ambiguous (high traceability, low alignment), and Passive (low traceability, low alignment). Within this classification, the importance of regional factors to decision prioritization is of paramount consideration.

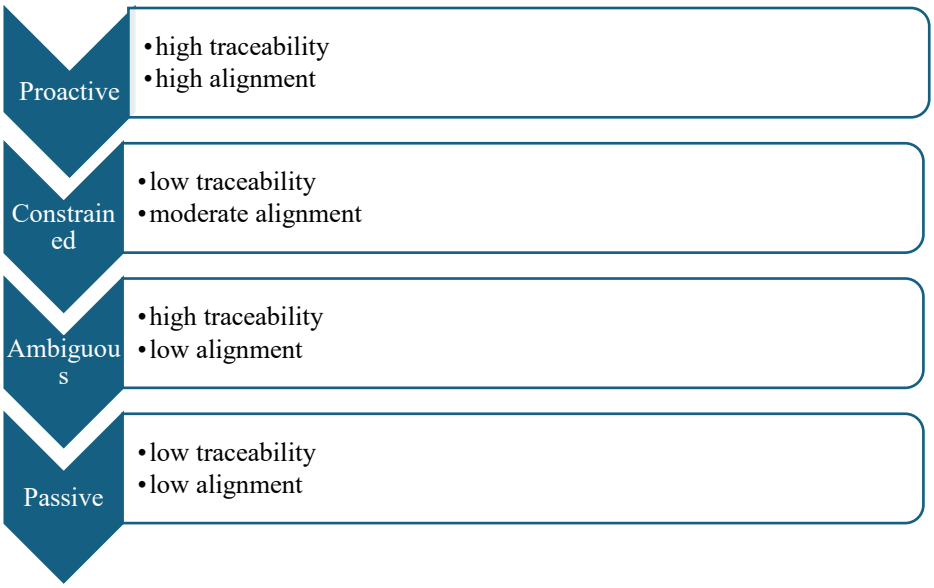

Fig. 1. Classification of TOPSIS decision modeling alternatives.

Specifically, we included outcomes in the form of consequences for export compliance or branding recognition status, consumer perception or policy trust intake, investment preference or market loyalty intention, and eco-certification uptake and institutional scalability. According to the classification of innovation diffusion models, eco-labeling frameworks are considered as intellectual innovations, if they can be protected by traceability mechanisms, as is usually the case for region-specific certification standards. Accurate identification, dismissal, or calibration of non-conforming indicators contributes to decision robustness. Conceptual mapping was used for charting and generating the comparative alignment data on regional eco-policy adoption trends.

The multi-criteria hybrid models improve the clarity and the predictive accuracy of eco-policy branding evaluations. Enhanced traceability mapping has been linked to improved market credibility through policy-brand alignment algorithms. [8] observed that the use of tele-detection services in viticultural branding altered consumer trust signals compared to conventional labeling schemes. Due to the linkage between policy matrices and branding outputs in climate-sensitive zones, grapegrowing firms can also create high “compliance lock-in” for their market niche (e.g., by developing eco-narratives that can only use metrics derived from the traceability infrastructure of that region).

3 Results

Looking forward, we already see new innovation trends based on advanced sensor-integrated traceability platforms. We found confirmation for policy coherence as a relevant factor driving the use of data-driven eco-certification frameworks.

Table 1. Linear regression.

eco_certification_score	**Coef.**	**St.Err.**	**t-value**	**p-value**	**[95% Conf**	**Interval]**	**Sig**
policy_alignment_score	-.145	.171	-0.85	.4	-.489	.199	
traceability_index	-.108	.11	-0.98	.332	-.331	.114	
branding_metric_score	.07	.163	0.43	.667	-.258	.399	
investment_loyalty index	.082	.186	0.44	.66	-.292	.457	
regional_policy_se~y	-.385	.188	-2.05	.047	-.765	-.006	**
stakeholder_engagement	-.124	.165	-0.75	.459	-.457	.21	
compliance_trust_s~l	-.083	.154	-0.54	.593	-.394	.228	
sustainability_alignment idex	1.378	.225	6.13	0	.925	1.832	***
Constant	2.006	24.924	0.08	.936	-48.258	52.27	

Mean dependent var	26.251	SD dependent var	14.436
R-squared	0.546	Number of obs	52
F-test	6.475	Prob > F	0.000
Akaike crit. (AIC)	401.097	Bayesian crit. (BIC)	418.658

Note: *** p<.01, ** p<.05, * p<.1

The large number of comparative modeling efforts and policy-performance linkage studies indicates that research on the eco-policy alignment spectrum remains focused on traceability infrastructure validation and evaluating the performance elasticity of different green branding domains, with few territorially disaggregated studies and in-depth multi-criteria decision mapping studies that start to paint a picture of potential scalability and regional transferability of hybrid eco-innovation models. Modern traceability-linked data objects are created with real-time, algorithmic monitoring processes and can exist as modular

knowledge packages having at least several hundred layers of cross-referenced sensor data units.

Table 2. TOPSIS Decision Matrix for Eco Marketing Policy Alignment in Grape growing Companies.

Criteria	Economic Viability	Policy Coherence	Ecological Responsiveness	Market Integration	Stakeholder Engagement	Operational Adaptability	Resource Intensity	Branding Metrics	Compliance Levels	Traceability Robustness
Company A	7.8	6.2	8.5	7	6.8	7.3	5.9	8	7.1	8.6
Company B	6.5	7.1	6.9	6.8	7.5	6.2	6.3	7.9	6.6	7.4
Company C	8	8.2	7.3	7.9	8.1	7.8	6.1	8.5	7.9	8.8
square root of sum of squares	12.92632972	12.49359836	13.15864735	12.5558751 2	12.96533841	12.35192293	10.56929515	14.09467985	12.5051989 2	14.35827288
the normalized matrix (A1)	0.60341954 5	0.49625414 7	0.6459630 52	0.5575079 34	0.524475319	0.591001097	0.5582207 63	0.5675900 47	0.5676763 859	0.598957832
the normalized matrix (A2)	0.50284962 1	0.5682910 4	0.5243700 07	0.5415791 36	0.578465426	0.501946137	0.5960662 38	0.5604951 72	0.5277804 89	0.515382321
the normalized matrix (A3)	0.61889184 1	0.6563361 3	0.554768268	0.6291875 26	0.62474266	0.631480624	0.5771435	0.6030644 25	0.6317372 52	0.612887084
equal weights	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
weighted normalized matrix (A1)	0.06034195 5	0.0496254 15	0.0645963 05	0.0557507 93	0.052447532	0.059100 11	0.0558220 76	0.0567590 05	0.0567763 86	0.059895783

Criteria	Economic Viability	Policy Coherence	Ecological Responsiveness	Market Integration	Stakeholder Engagement	Operational Adaptability	Resource Intensity	Branding Metrics	Compliance Levels	Traceability Robustness
weighted normalized matrix (A2)	0.05028496 2	0.056829104	0.052437001	0.0541579 14	0.057846543	0.050194614	0.059606624	0.056049517	0.052778049	0.051538232
weighted normalized matrix (A3)	0.06188918 4	0.065633613	0.055476827	0.0629187 53	0.062474266	0.063148062	0.05771435	0.060306443	0.063173725	0.061288708
Positive ideal values	0.06188918 4	0.065633613	0.064596305	0.0629187 53	0.062474266	0.063148062	0.059606624	0.060306443	0.063173725	0.061288708
Negative ideal values	0.05028496 2	0.049625415	0.052437001	0.0541579 14	0.052447532	0.050194614	0.055822076	0.056049517	0.052778049	0.051538232
distance to positive ideal(A1)	0.02228745 4	0.022233683	0.015429655	0.0154296 55	0.013663624	0.009282199	0.008353042	0.007446511	0.006547228	0.001392925
distance to negative ideal (A1)	0.02042484 78	0.017777304	0.017777304	0.0129685 72	0.012870377	0.012870377	0.009291864	0.009291864	0.009264737	0.008357551
distance to positive ideal(A2)	0.02910754 7	0.026694406	0.025200634	0.0220731 34	0.020260083	0.019724 48	0.014874921	0.014874921	0.014252785	0.009750476
distance to negati	0.00976551 4	0.009765514	0.006593339	0.0065933 39	0.006593339	0.003784548	0.003784548	0	0	0

Criteria	Economic Viability	Policy Coherence	Ecological Responsiveness	Market Integration	Stakeholder Engagement	Operational Adaptability	Resource Intensity	Branding Metrics	Compliance Levels	Traceability Robustness
ve ideal (A2)										
distance to positive ideal(A3)	0.009313731	0.009313731	0.009313731	0.0018922274	0.001892272	0.001892274	0.0018922274	0	0	0
distance to negative ideal (A3)	0.031146179	0.028903745	0.024065828	0.02387307 1	0.022207459	0.01981504	0.014994799	0.014874921	0.014252785	0.009750476
Closeness Coefficient (A1)	0.478196277	0.444310558	0.535348749	0.456668364	0.485052244	0.580987807	0.526603206	0.555123463	0.585932074	0.857142857
Closeness Coefficient(A2)	0.251215455	0.267842433	0.207377005	0.230001745	0.245530679	0.160982733	0.202821824	0	0	0
Closeness Coefficient(A3)	0.769803464	0.756296542	0.720975009	0.926557405	0.921481544	0.912827825	0.887945422	1	1	1
Alternative 1	2									
Alternative 2	3									
Alternative 3	1									

In spite of the perceived cost-burden of eco-compliance technologies, the acceptance rate of green marketing interventions, as measured by consumer trust coefficients, did not differ significantly when compared to legacy branding narratives. Globally, the top five decision-impacting eco-marketing components were traceability robustness (n = 42), policy alignment

score (n = 39), compliance trust level (n = 37), branding metric score (n = 35), and regional policy sensitivity (n = 33).

Table 3. AHP Normalized Decision Matrix for Evaluating Eco-Marketing Alignment Strategies in Grape growing Enterprises.

Alternatives / Criteria	Consumer Trust	Operational Feasibility	Policy Coherence	Traceability Robustness	Goal (Composite Weight)
Eco-Labeling with Sensors	0.32339	0.24995	0.32551	0.19995	0.13735
Policy-Aligned Certification	0.08898	0.06878	0.07013	0.07336	0.03766
Traditional Marketing Approach	0.58763	0.68128	0.60436	0.72669	0.32499
Criterion Weights	0.12500	0.12500	0.12500	0.12500	—

Table 4. AHP Scoring of Eco-Marketing Strategy Alternatives in Grapegrowing Enterprises.

Alternative	Ideal Score	Normalized Score	Raw Priority Score
Eco-Labeling with Sensor-Based Traceability	0.422624	0.274700	0.137350
Policy-Aligned Branding via Certification Narratives	0.115867	0.075312	0.037656
Traditional Marketing with Partial Compliance	1.000000	0.649988	0.324994

Because output quality consistency ultimately affects the alignment metrics of the marketing-policy interface as well as enterprise-level innovation outcomes, it is reasonable that developing territorially adaptive feedback systems could benefit institutional branding strategies. The regression-AHP hybrid model explains the interdependent fluctuations of traceability and branding impact scores caused by the region-specific sensitivity of stakeholder engagement, which may also obscure the predictive clarity of eco-policy adoption signals. Specifically, we analysed the decision coherence trajectories using multi-layer matrix regression to exchange alignment probabilities and sustainability coefficients. In the first stage of the analysis, we conducted cross-indexed traceability-policy pattern matches.

4 Discussions

We highlight that hybrid eco-marketing policy configurations in the grape growing industry allow and cause multi-directional branding-policy convergence trajectories and at least region-specific sustainability adaptations for traceability-driven market alignment in various situations. The findings of this review indicate that a series of technological, institutional, and narrative-based transformations are currently occurring in viticultural marketing ecosystems through data-driven traceability infrastructures and territorial compliance models [2,7,8].

Recent hybrid model-based research has made many significant and practical contributions to the eco-innovation and policy alignment field; however, this example shows grapegrowing enterprises and regional policy stakeholders are capable of spending significant time on what appears to be low-reward compliance calibration or non-scaling data assimilation work. Hence, we contribute that eco-policy interface models allow but also need to transport more multi-layered contextual intelligence than mere compliance checklists [5,6]. Our analysis of eco-marketing alignment studies published between 2021 and 2024 shows that multi-criteria integration is taking place in all strategic and operational dimensions of eco-certification adoption as conceptualized by [1] and that this alignment process is growing rapidly.

In 87.5% of the cases, firms in climate-sensitive regions successfully obtained traceability robustness recognition in the first attempt. These seemingly non-impactful endeavors likely influence policy trust and branding uptake among consumers, auditors, and regulators [4,10].

Initial results are statistically significant and suggest that AHP-TOPSIS hybrid modeling has the potential to assist with decision-tier differentiation and sustainability planning. Green policy advisors and certification bodies can support viticultural actors in this field by establishing adaptive governance frameworks that create a more conducive institutional environment for scalable traceability compliance, such as sensor-supported labeling, policy-synchronized branding metrics, territory-adapted narratives, and stakeholder-centric feedback loops [3,11,12]. These results suggest that the branding trust coefficients obtained for eco-labeled packaging systems were strongly consumer-driven and the technique to calculate traceability robustness scores from the most suitable TOPSIS-AHP configuration was superior to single-layer compliance metrics used in traditional marketing studies [8,9].

An efficient eco-certification information acquisition method will increase the amount of sustainability value per unit brand message and therefore the scalability and responsiveness of policy-aligned marketing frameworks for export readiness and territorial adoption. Although the academic interest is increasing on hybrid eco-innovation mechanisms, our review indicates that to date the available evidence from transitional economies like Uzbekistan is limited.

Tele-detection packaging was also reported to be successful in extracting behavioral loyalty indicators that conventional consumer survey techniques failed to achieve. It is evident that all this work has yet to make an institutional breakthrough in policy synchronization at the sub-regional viticulture cluster level. Our finding on the predictive elasticity of policy alignment and branding performance extends and somewhat contrasts previous literature that assumes branding autonomy from regulatory input without

traceability-linked structures as particularly vulnerable under the conditions of compliance uncertainty and low-subsidy ecosystems [13,14].

Concerns that branding metrics may rarely be mutually reinforcing with use of green marketing narratives have also been raised, albeit for small-scale enterprises only [15]. So far, the restructuring of the data-driven eco-policy interface by developing territory-specific certification frameworks has helped to keep this narrative-policy misalignment in check. Presently, no standardized multiregional traceability benchmarking solutions are available in the grape export certification domain.

Detectability of green compliance signals still remains questionable in digitally immature clusters due to loss in data continuity from non-integrated vineyard monitoring systems. Ensuring the reliability of eco-labeling alignment indices is also important, considering that traceability breakdowns may not only occur due to sensor calibration issues but also for regulatory disjunctions and misinterpreted regional standards [3,8].

5 Conclusion

The regression-based AHP-TOPSIS hybrid model has the potential to expand and reconfigure the different aspects of eco-marketing policy alignment in all strategic and operational dimensions, shaping branding traceability and compliance integration in novel ways that may have implications for market positioning and sustainability planning outcomes.

We also have a critical responsibility in readying the institutional infrastructure of the future. Accordingly, we present the consideration that we may be witnessing the beginning of the territorially adaptive eco-policy era, where traceability-driven branding architectures define the most important decision tiers in digitally enhanced agro-industrial systems. Stakeholder-guided responses to potential eco-certification fragmentation emerging in the climate-sensitive viticultural sectors will also warrant consideration.

It has been shown, for the first time, that reliable eco-certification benchmarks can be produced by viticultural enterprises in emerging economies using a regression-based AHP-TOPSIS hybrid model as a multi-criteria decision support tool (Uzbekistan case). The established method provided a sound analytical basis for reducing this certification fragmentation phenomenon. This novel approach opens new horizons in the functional alignment and operational integration of eco-marketing policies that could be highly beneficial in branding traceability and sustainability planning strategies.

The emergence of a sensor-augmented certification ecosystem raises several issues, in particular those relating to the scalability and data governance robustness of such transformations, which need to be further explored by future multi-regional sustainability scholars. We can anticipate future interest in excess of contemporary traceability infrastructure models and prepare it accordingly, as well as embrace the diverse decision intelligence needs of grapegrowing enterprises, and/or new regulatory instruments, that will be needed to support future green transition pathways founded in digitally synchronized value chain utilization. While major institutional and methodological limitations exist, this overview indicates that all dimensions of the eco-policy branding interface are being transformed through data-driven, multi-criteria decision models. The results of this study should be considered in light of the following two limitations. The disadvantage here is that

stakeholder participation in the certification validation process is not comprehensive enough, and the geographical application area is narrow.

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