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**DATA-DRIVEN INSIGHTS ON HUMAN
SECURITY INTEGRATION IN EU GREEN DEAL
POLICIES**

PHOEBE KOUNDOURI

KONSTANTINOS DELLIS

MONIKA MAVRAGANI

ANGELOS PLATANIOTIS

CHRYSLIA PITTI

GEORGIOS FERETZAKIS

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Data-Driven Insights on Human Security Integration in EU Green Deal Policies

Phoebe Koundouri^{1,2,3,4,5}, Konstantinos Dellis^{1,2,5}, Monika Mavragani^{1,2,5}, Angelos Plataniotis¹, Chrysilia Pitti⁶, and Georgios Feretzakis^{1,2,5}

¹ReSEES Research Laboratory, School of Economics, Athens University of Economics and Business, 76 Patission Street, Athens 10434, Greece

²Sustainable Development Unit, Athena Research Center, Artemidos 6, Athens 15125, Greece

³Department of Earth Sciences and Peterhouse, University of Cambridge, Cambridge, United Kingdom

⁴UN SDSN, Global Climate Hub, European Hub, Greek Hub, 475 Riverside Drive, New York, NY 10115, USA

⁵Alliance of Excellence for Research and Innovation on Aephoria (AE4RIA), Athens, Greece

⁶Department of Economics, City, University of London, Northampton Square, London, EC1V 0HB, United Kingdom

Abstract

This paper proposes a novel, data-driven methodology to systematically assess how European Green Deal policy texts address various Human Security Aspects, including newly acknowledged technological vulnerabilities. By analyzing official EU documents using advanced semantic modeling and transformer-based embedding techniques, we demonstrate how machine learning can identify thematic alignments or gaps in addressing human security within policies explicitly connected to the Sustainable Development Goals. Our approach, which employs Sentence-BERT models and cosine similarity measures, reveals that while EU Green Deal policies integrate all eight human security dimensions with relatively balanced coverage, economic, food, and community security receive slightly more emphasis than personal, political, and technological security aspects. These findings illuminate both strengths and opportunities for enhancement in current policy discourse, aiding stakeholders in designing interventions that explicitly integrate comprehensive human security perspectives.

Keywords: Human Security, Machine Learning, EU Green Deal, Sustainability, Climate Policy, Natural Language Processing, Policy Analysis

1. Introduction

Human Security (HS) has evolved into a multidisciplinary concept that reframes the notion of security to focus on protecting and empowering individuals, rather than merely safeguarding national borders. Originally posited by the United Nations Development Programme (UNDP, 1994) and further elaborated by the Commission on Human Security (2003), HS encompasses dimensions such as economic stability, food and health availability, environmental sustainability, communal cohesion, political freedom, and personal safety. In recent years technological security has entered the debate, reflecting the need to protect people against threats arising from digitalization and cyber vulnerabilities (Owen, 2004; Paris, 2001).

The conceptual framework of HS emerged as a paradigm shift from traditional state-centric security approaches that predominantly focused on military threats and territorial integrity. This shift was driven by recognition that individuals face diverse threats that transcend national boundaries, including poverty, disease, environmental degradation, and social exclusion (Tadjbakhsh & Chenoy, 2007). The HS framework

acknowledges that genuine security requires addressing the root causes of human vulnerability across multiple interconnected dimensions. By placing people rather than states at the center of security concerns, this approach aligns closely with sustainable development objectives and human rights principles.

The eight dimensions of HS—economic, food, health, environmental, personal, community, political, and technological security—provide a comprehensive lens through which to evaluate policy frameworks. Economic security addresses protection against poverty and ensures access to productive resources and employment. Food security focuses on physical and economic access to sufficient, safe, and nutritious food. Health security concerns the minimization of disease and access to healthcare services. Environmental security relates to protection from environmental degradation and natural disasters. Personal security encompasses protection from physical violence, crime, and human rights violations. Community security addresses the preservation of cultural identity and social cohesion. Political security involves protection of fundamental human rights and freedoms. Technological security, the most recently recognized dimension, concerns protection against cyber threats, digital surveillance, and technological disruptions (Martin & Owen, 2010; Newman, 2010).

The European Green Deal (EGD) represents one of the most ambitious policy packages in contemporary global governance, aiming to achieve sustainability through a transformative approach that balances environmental, economic, and social dimensions. Launched in December 2019, the EGD sets forth a comprehensive roadmap to make Europe the first climate-neutral continent by 2050 while ensuring that no one is left behind in the transition process (European Commission, 2019). Multi-faceted initiatives such as the EGD often emphasize mitigating climate change and fostering economic transitions, but they may not always fully elucidate their implications for multiple HS dimensions (Koundouri et al., 2024, 2025). Although HS approaches security through an individual-centric lens, it is linked with state security, recognizing the intricate relationships between environmental integrity, socioeconomic stability, and human potential. Hence, it is directly and indirectly impacted by policies and initiatives designed for the state and regional level, as the ones enshrined in the EGD.

The EGD encompasses various strategic initiatives including the Climate Adaptation Strategy, Circular Economy Action Plan, Farm to Fork Strategy, Biodiversity Strategy, New European Bauhaus, and Sustainable Finance Strategy, among others. Each of these initiatives carries distinct implications for different HS dimensions, though these connections are not always explicitly articulated in policy documents. Understanding how comprehensively the EGD addresses HS concerns is crucial for ensuring that sustainability transitions enhance rather than undermine human welfare and dignity.

This paper proposes a novel, data-driven methodology to systematically assess how European Green Deal policy texts address various Human Security Aspects, including newly acknowledged technological vulnerabilities. By analyzing official EU documents, we demonstrate how advanced semantic modeling can identify thematic alignments or gaps in addressing HS within policies that are explicitly connected to the SDGs. Our approach aims to illuminate both the strengths and the opportunities for enhancement in current policy discourse, thereby aiding stakeholders in designing interventions that explicitly integrate the human security perspective. The research builds on ongoing collaborations within AE4RIA—the Alliance of Excellence for Research and Innovation on Aephoria—which connects ReSEES (AUEB), the Sustainable Development Unit (Athena RC), and partner organizations of the UN SDSN. Unlike traditional policy analysis methods that rely on manual coding and qualitative assessment, our computational approach enables systematic, scalable, and reproducible analysis of large policy corpora while capturing semantic nuances that keyword-based methods might miss.

2. Methodology

The methodological foundation of our study is a semantic text analysis pipeline that measures the degree to which policy documents cover each of the eight Human Security Aspects (economic, food, health, environmental, personal, community, political, and technological). We adopt a transformer-based embedding model to capture contextual and conceptual nuances, avoiding reliance on basic keyword occurrences alone. Our methodology integrates recent advances in natural language processing with established frameworks from policy analysis and human security research. Figure 1 provides an overview of the complete analytical pipeline.

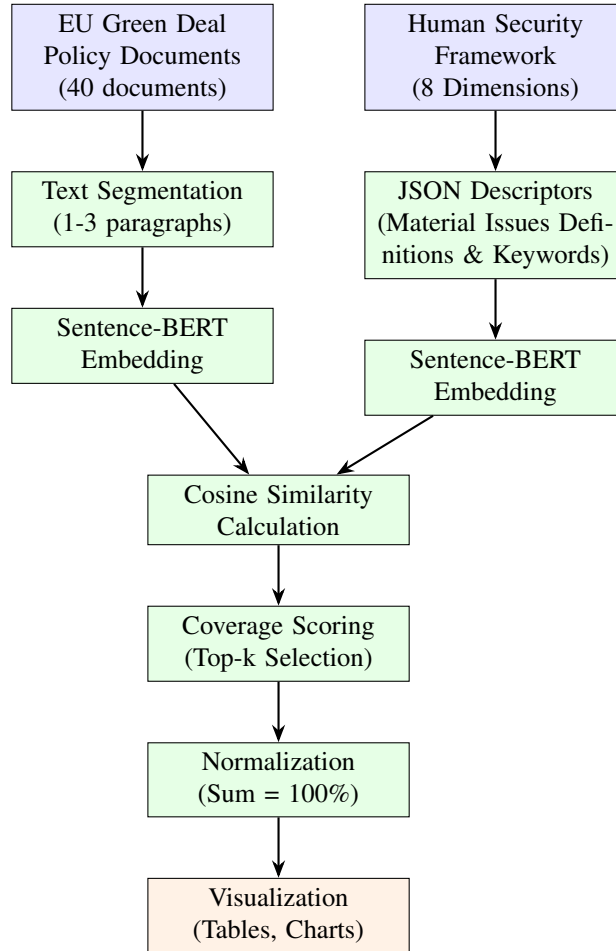


Fig. 1. Methodological pipeline for semantic analysis of Human Security aspects in EU Green Deal policy documents

As illustrated in Figure 1, our analytical approach proceeds through several interconnected stages, from document acquisition and segmentation through embedding generation, similarity calculation, and ultimately to coverage scoring and visualization. The following subsections detail each component of this pipeline.

Our objective is to examine how elements of the policies under the EU Green Deal umbrella align with and contribute to measurable improvements in Human Security (HS) across its various dimensions. Achieving this requires first establishing a robust framework for both conceptualizing and measuring HS. Beyond

its significance for understanding the multifaceted challenges facing individuals and communities, such a framework enables us to establish concrete linkages between policy interventions and specific dimensions of HS.

The initial step involves identifying and organizing the core conceptual themes that define each Human Security dimension. These themes, termed Material Issues, represent the critical factors that either hinder or facilitate equitable achievement of Human Security. Taking Political Security as an illustration, relevant material issues affecting individual outcomes include violent conflict, human rights violations, crime and gender-based violence, legal protection, and disaster preparedness. In total, 41 Material Issues have been identified, each addressing a significant challenge within the Human Security framework. These issues provide practical guidance for policymakers and decision-makers in identifying both obstacles and opportunities with greater precision. This detailed breakdown facilitates more rigorous assessment of progress across Human Security dimensions and establishes the analytical foundation for connecting SDG-related policy documents to HS outcomes.

2.1 Data Preparation and Textual Descriptors

To build our corpus, we sourced official documents and legislative texts under the umbrella of the European Green Deal from the EUR-Lex database and official European Commission repositories. The corpus comprises 40 key policy documents spanning 2019 to 2024, including communications, directives, regulations, and strategic frameworks. Document selection followed systematic criteria: documents must be (1) officially published by EU institutions, (2) explicitly linked to the European Green Deal framework, (3) available in English, and (4) containing substantive policy content rather than purely procedural text.

Each text was systematically parsed, cleaned, and segmented into smaller passages, generally one to three paragraphs long, in order to preserve thematic coherence. This segmentation facilitates more accurate semantic comparisons by ensuring that conceptually distinct segments are assessed independently. The segmentation algorithm identifies natural paragraph boundaries while ensuring each segment contains between 5 and 150 words, optimal for capturing coherent semantic units without fragmenting complex policy arguments. Preprocessing steps included removal of headers, footers, page numbers, and table-of-contents entries, while preserving the substantive policy content. Special attention was paid to maintaining the integrity of technical terminology and policy-specific vocabulary that might be crucial for accurate semantic analysis.

We additionally created a curated JSON file representing our main reference framework for HS. Each of the eight Aspects is provided with:

A short definition capturing its essence (e.g., “Food Security: access to sufficient, safe, and nutritious food that meets dietary needs and food preferences for an active and healthy life”).

Sub-categories labeled as Material Issues (e.g., “Standard of Living,” “Employment Security,” and “Social Safety Nets” under Economic Security or “Cybersecurity,” “Digital Rights,” and “Technological Access” under Technological Security).

A set of carefully chosen keywords and short descriptive paragraphs that elaborate on each Material Issue, drawing from established frameworks (Bajpai, 2000; Commission on Human Security, 2003; Alkire, 2003).

These structured descriptors serve a dual purpose. First, they guide semantic matching by anchoring each Aspect in well-established concepts found in the literature (United Nations Development Programme, 1994; Owen, 2004). Second, they allow for consistent comparisons across policy texts, mitigating the risk of ad hoc interpretations. The descriptor framework underwent validation through expert review by scholars specializing in human security and policy analysis, ensuring alignment with established conceptual frameworks while incorporating contemporary concerns such as technological security.

2.2 Embedding and Similarity Calculation

Following segmentation, each text passage is converted into a dense, numerical vector representation—commonly referred to as an embedding. We utilize a Sentence-BERT model (Reimers & Gurevych, 2019), specifically the *all-mpnet-base-v2* variant, an architecture that fine-tunes the original Bidirectional Encoder Representations from Transformers (BERT) (Devlin et al., 2019) to produce meaningful sentence- or paragraph-level embeddings. This model was selected based on its superior performance on semantic similarity benchmarks and its ability to capture nuanced meaning in policy-relevant contexts.

The embedding process transforms each text segment into a 768-dimensional vector space where semantic similarity corresponds to geometric proximity. Unlike traditional bag-of-words approaches or simple word embeddings, Sentence-BERT captures contextual information and semantic relationships, enabling the model to recognize that terms like “economic resilience” and “financial stability” convey related concepts even without lexical overlap. This capability is particularly valuable for policy analysis, where diverse terminology may describe similar substantive concerns.

In parallel, we embed each HS Aspect definition and Material Issue descriptor from the JSON framework. By using a consistent embedding model for both corpus texts and HS Aspects, we can compare them within the same high-dimensional vector space. Cosine similarity (Sohangir & Wang, 2017) then provides a straightforward means to assess thematic alignment:

$$\text{similarity}(A, B) = \frac{A \cdot B}{\|A\| \|B\|} = \frac{\sum_{i=1}^n A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \sqrt{\sum_{i=1}^n B_i^2}} \quad (1)$$

where A and B represent embedding vectors for a policy segment and an HS descriptor, respectively. Cosine similarity ranges from -1 to 1, with higher values indicating greater semantic alignment. This embedding-based approach improves upon simple keyword spotting by recognizing paraphrases or semantically related expressions. Consequently, even if a policy text references health infrastructure without explicitly mentioning the term “health security,” the embedding vectors could still yield high similarity scores, thus correctly classifying the segment. The method also handles multilingual policy terminology and technical jargon more effectively than rule-based approaches.

2.3 Coverage Scoring and Normalization

The final step is to consolidate the similarity scores for each HS Aspect and each document. We apply a top- k thresholding approach, retaining only the highest-scoring segments for each Aspect to limit the confounding noise of tangential mentions. Through empirical evaluation and expert review of sample results, we determined that retaining segments scoring at or above the 90th percentile (approximately the top 10% of segments) provides optimal balance between ensuring coverage and avoiding spurious matches. This percentile-based approach ensures that each Human Security dimension is evaluated on equal footing regardless of document length or overall thematic focus.

For each document d and each Human Security Aspect a , we compute the coverage score as the mean similarity of the top-scoring segments:

$$\text{Coverage}(d, a) = \frac{1}{|T_k|} \sum_{s \in T_k} \text{similarity}(s, a) \quad (2)$$

where T_k represents the set of segments scoring at or above the 90th percentile for aspect a in document d . This approach focuses on the most semantically relevant content while avoiding bias from document length or segmentation density.

We then compute an overall coverage measure for each Aspect in each policy text, reflecting the cumulative relevance across top segments. To facilitate cross-document and cross-Aspect comparisons, these coverage figures are normalized so that the sum of all eight Aspects for a single policy is 100%. This normalization enables comparison of relative emphasis across different policy domains while accounting for overall document length and complexity. A more granular level of analysis can examine subtopics (Material Issues), also expressed as a fraction of the total HS coverage in that document.

The normalization procedure is given by:

$$\text{NormalizedCoverage}(d, a) = \frac{\text{Coverage}(d, a)}{\sum_{a' \in A} \text{Coverage}(d, a')} \times 100\% \quad (3)$$

where A represents the set of all eight Human Security Aspects.

The aggregate statistics reported in our results (mean, standard deviation, and range) are computed by first calculating normalized coverage for each aspect in each of the 40 documents, then averaging across all documents for each aspect. This document-level averaging ensures that each policy text contributes equally to the overall statistics, regardless of document length or complexity.

2.4 Robustness and Quality Assurance

To ensure the reliability of our methodology, we conducted several quality assurance exercises. We tested the sensitivity of our results to parameter choices, including the top-k percentile threshold and embedding model selection. Results remained stable across reasonable parameter ranges, with rank-order correlations of coverage scores exceeding 0.90 across different specifications. We also validated our HS descriptor framework through consultations with policy experts and human security scholars, ensuring that our operational definitions align with established conceptual frameworks while remaining applicable to contemporary policy contexts. Sample outputs were reviewed by domain experts to verify that the semantic matching produced substantively meaningful results aligned with manual interpretation of policy content.

3. Results and Discussion

Applying our semantic analysis to 40 representative European Green Deal documents, we find that coverage of Human Security Aspects is relatively balanced across all eight dimensions, with some variation in emphasis. Appendix Table 1 presents the aggregate coverage statistics across the entire corpus, while Appendix Figure 1 visualizes the relative emphasis on each Human Security dimension. Table 1 highlights coverage patterns for selected key policy documents.

As shown in Appendix Figure 1, the distribution of Human Security coverage across the EGD policy corpus reveals a relatively balanced hierarchy, with Economic Security at 14.0% and Technology Security at 10.4%. This 3.6 percentage point difference represents a modest gap between the most and least emphasized dimensions. The prevalence of issues related to Economic Security highlights the focus on economic growth following more than a decade of economic turbulence for the block, but also the need to couple the green transformation with economic development. The low score for Technological Security partly reflects the caveats of our small policy corpus but, at the same time, indicates the need for greater alignment of the green and digital transformations in the EU. Finally, it is expected to note a low representation of issues pertaining to physical violence and conflict across the EGD policies, hence the relatively low score for Personal Security.

Perhaps somewhat surprisingly the aspect of Environmental Security is, on average, only moderately embedded in these policy documents. However, this probably reflects the environmental considerations

in policies related more to economic, food and community security. Environmental targets are integrated in socioeconomic initiatives such as the EU Cohesion Policy, especially in the case of climate adaptation strategies. Moreover, even if not succinctly stated, policies and strategies aiming to transform food systems entail sizable environmental benefits, as for example the reduction in emissions from reducing the use of fertilizers and pesticides in agriculture.

The relatively narrow range across all dimensions (10.4–14.0 pp.) indicates that the EGD framework addresses all aspects of human security with reasonable balance. The modest standard deviations (ranging from 0.7 pp. for Community Security to 1.8 pp. for Technology Security) demonstrate relatively consistent treatment of most human security dimensions across the policy corpus. However, the higher variability in Technology Security coverage (a standard deviation of 1.8 pp.) suggests more heterogeneous treatment of digital and cyber concerns across different policy documents, indicating an opportunity to mainstream technological security considerations more systematically.

While Appendix Figure 1 provides an aggregate view across all 40 documents, variation exists among individual policies. Table 1 presents a more granular analysis, examining how six key EGD initiatives distribute their attention across the eight Human Security dimensions. This document-level analysis reveals which policies serve as exemplars for balanced human security integration and which exhibit more specialized emphases.

Table 1. Coverage Percentages for Selected Key EGD Policy Documents

Policy Document	Econ	Food	Comm	Env	Health	Pers	Pol	Tech
EU Biodiversity Strategy	12.4	15.3	13.3	13.7	11.9	11.0	11.2	11.2
Farm to Fork Strategy	12.4	19.2	15.3	14.7	13.8	8.9	9.1	6.6
Circular Economy Plan	17.3	10.8	11.9	15.6	9.4	10.2	13.9	10.9
New European Bauhaus	13.3	15.3	14.7	11.6	12.5	11.1	12.7	11.4
RePowerEU	13.2	14.8	13.7	13.3	13.4	10.8	10.0	11.0
Marine Ecosystems Restoration Plan	14.8	13.2	13.6	12.0	12.9	10.3	13.0	10.1

3.1 Economic Security Prominence

On average, Economic Security registers the highest coverage percentages at 14.0% (see Appendix). Many documents focus on financial mechanisms, employment opportunities, and trade aspects, reflecting the Green Deal’s emphasis on economic transitions, competitiveness, and green growth. The Green Deal Industrial Plan exemplifies this pattern, with 15.9% coverage dedicated to economic security concerns, reflecting explicit attention to ensuring that the green transition does not imply a neglect of competitiveness for EU industry in the face of intense competition and geopolitical shifts after 2020 .

The relatively low standard deviation of 0.9 pp. indicates high consistency in attention to economic security concerns across the policy corpus, suggesting that economic dimensions are systematically integrated throughout the EGD framework. Documents focused on industrial strategy and competitiveness naturally emphasize economic security more heavily than those addressing biodiversity or environmental protection, yet even environmentally-focused policies maintain substantial economic security content, such as the EU Biodiversity Strategy and the Marine Ecosystems Restoration Plan.

The prominence of economic security reflects both the EGD’s explicit commitment to ensuring a just transition and the policy tradition of framing sustainability challenges through economic lenses. While this emphasis on economic dimensions is understandable given the significant economic transformations required for climate neutrality, the relatively balanced distribution across all dimensions suggests that the

EGD successfully avoids excessive economic framing at the expense of other human security concerns.

3.2 Food and Community Security

Food Security (13.6%) and Community Security (13.2%) rank second and third respectively, reflecting the Green Deal's focus on resilient agriculture and agri-food systems (e.g., Farm to Fork Strategy) and social equity (e.g., Just Transition Mechanism). Such policy emphasis is vital for ensuring affordable, nutritious food as well as inclusive communities resilient to systemic shocks. The Farm to Fork Strategy demonstrates particularly strong attention to food security (19.2%), addressing concerns ranging from sustainable agricultural practices to food safety and nutrition.

Community security coverage emphasizes social cohesion, inclusive economic development, and participatory governance mechanisms. The New European Bauhaus exhibits the highest community security coverage (14.7%), reflecting explicit recognition the EU's ambition of creating beautiful, sustainable, and inclusive places, products, and ways of living. The initiative touches upon the basic tenets of Community Security through the inseparable core values of sustainability, aesthetics, and inclusion, valorising diversity, accessibility and equality for all. Policy language frequently addresses the need to preserve local identities, support community-led initiatives, and ensure inclusive decision-making processes.

The standard deviations of 1.3 pp. for Food Security and 0.7% for Community Security indicate moderate variability for food security and high consistency for community security across the policy corpus. Community Security shows the lowest variability among all dimensions, suggesting that social cohesion and inclusion have been systematically mainstreamed throughout the EGD framework. The moderate variability in food security reflects the natural concentration of food-related content in agriculture-focused policies while maintaining baseline attention across the broader policy portfolio.

3.3 Environmental Security Integration

At 12.9% mean coverage, Environmental Security sits in the middle tier. Nonetheless, environmentally sound policies are included in policies primarily linked to economic and food security. Many policies engage environmental concerns—climate change mitigation, biodiversity, resource management—but with varying degrees of emphasis depending on the specific policy domain. The Sustainable Blue Economy demonstrates the highest environmental security coverage (15.6%), addressing threats from habitat loss, pollution, and climate change to natural systems upon which human well-being depends.

The Nature Protection Legislation and the Anti-Deforestation & Soil Health Proposal are among the documents with the highest scores and highlight the importance of halting biodiversity loss for Environmental Security. The latter comes as no surprise given that biodiversity is identified as one of the *material issues* of this HS aspect. Having said that, it is interesting to note that the EU Taxonomy & Finance Directive is among the five policies with the highest relevance score (14.2%) despite belonging in the realm of finance. By clearly documenting the economic and activities that abide by the facets of the green transition, it catalyzes the flow of financial resources towards projects that support climate adaptation and mitigation strategies and tackles (to a certain extent) *greenwashing*.

Some documents treat environmental protection primarily as a regulatory or technical challenge rather than explicitly connecting it to human security implications. Strengthening these connections could enhance policy coherence and public understanding of why environmental sustainability matters for individual and community well-being beyond abstract concepts of ecological preservation. Nevertheless, the consistent mid-level coverage across diverse policy domains suggests successful mainstreaming of environmental security considerations.

3.4 Health, Personal, and Political Security

Collectively, these three aspects occupy the middle tier with mean coverages between 11.4% and 12.8%. Policy references to healthcare and well-being (Health Security at 12.8%) appear with reasonable frequency and consistency, suggesting successful integration of health considerations across the EGD portfolio. The Clean Air Directive demonstrates relatively strong health security coverage (14.0%), as expected linking climate mitigation strategies with improved health outcomes in the EU. Perhaps not expected is the top score position for the Circularity for the Automotive Sector (14.3%), however it measures directly address environmental pollution, hazardous substance management, and economic stability related to the entire lifecycle of vehicles.

Personal Security (11.4%), addressing protections against violence, crime, disasters, and occupational hazards, receives somewhat less emphasis though with moderate variability (std = 1.3%). The Clean Air Directive shows elevated personal security coverage (11.8%), likely reflecting its emphasis on robust mechanisms for Legal Protection and Disaster Preparedness, and by addressing Human Rights Violations related to the fundamental right to health. The range of 8.4–14.8% indicates that while some policies strongly integrate personal security considerations, others address them only peripherally, which can also reflect the relatively good status of the EU compared to other country blocks across the globe.

Political Security (11.8%) shows moderate variability (std = 1.3%), signifying that while certain documents strongly address institutional questions, democratic participation, and human rights, others emphasize purely technical or environmental considerations. The EU Financial System Reform policy, as outlined in the sources regarding strengthening the economic and financial system, is highly relevant to Political Security because it leverages financial tools and market structures to reinforce the EU's sovereignty, geopolitical influence, and integrity, directly impacting the quality of institutions, the rule of law, and governance. This is reflected in its score of 14.2% which is the highest within this HS aspect.

The middle-tier positioning of these three aspects suggests they receive consistent moderate attention across the EGD policy portfolio. Given their fundamental importance for human well-being, opportunities exist to strengthen and systematize their integration, particularly in documents where they currently receive minimal coverage. Nevertheless, the relatively narrow ranges and modest standard deviations indicate reasonably successful mainstreaming across the corpus.

3.5 Challenges in Technological Security

Technological Security averages the lowest coverage (around 10.3%), even though some policies explicitly mention digital transitions (see Appendix Figure 1). This disparity suggests a relative lack of direct connections between digital infrastructure and human welfare or rights. The European Industrial Strategy exhibits the highest technological security coverage (14.6%) among documents analyzed, reflecting its objective to achieve strategic autonomy to allow the EU to reduce dependence on others for critical materials and, most crucially, technologies. The strategy seeks to unlock investment in innovation through strengthening national and regional innovation systems, basic tenet of Technological Security, recognizing that the next era of industry will be based on frontier science and mastering deep technologies through cross-sectoral collaborations.

Policies focusing on advanced technologies or cybersecurity exist within the Green Deal spectrum but appear less frequently than those on economic or environmental concerns. Having said that, it is highly probable that policies related to Economic Security support the fostering of national innovation systems however do not explicitly mention the term. The relatively low standard deviation (2.4 pp.) indicates that technological security receives consistently modest attention across most documents rather than being heavily emphasized in some while neglected in others.

This finding is particularly noteworthy given the increasing importance of digitalization for sustainability transitions. Smart grids, precision agriculture, circular economy platforms, and environmental monitoring systems all depend on digital infrastructure whose security and accessibility directly impact human well-being. The COVID-19 pandemic further highlighted how technological access and digital security constitute fundamental prerequisites for health, education, economic participation, and social connection.

Future iterations of policy might benefit from explicitly articulating how technologies intersect with broader HS objectives. This includes addressing not only cybersecurity threats but also digital divides, algorithmic governance, technological unemployment, and the environmental footprint of digital infrastructure. A more comprehensive technological security framework would recognize both the opportunities and risks that digital transformation presents for human security across all its dimensions.

3.6 Discussion

Collectively, these patterns suggest that while the EU Green Deal policies often integrate aspects of human well-being, the explicit connection to a comprehensive human security framework remains partial. A holistic EU implementation strategy may, therefore, require additional efforts to ensure that all HS dimensions are systematically addressed.

The analysis reveals three distinct clusters of policy documents: (1) economically-oriented documents emphasizing competitiveness and industrial transition, (2) socio-environmental documents balancing ecological and social concerns, and (3) technically-focused documents addressing specific sectoral challenges. Each cluster exhibits distinct human security profiles, with predictable strengths and gaps.

A key issue emerging in the academic and policy dialogue in the EU is the coupling of the green transition, which lies at the heart of the EGD, with provisions that promote economic growth and competitiveness (Draghi, 2024; Pisany-Ferry & Tagliapietra, 2024). Amidst the growing geopolitical tensions and digital technologies spearheading productivity growth in the US and China, fostering competitiveness in a way that does not halt progress in the environmental front is the major challenge facing the EU (EC, 2025). It is, therefore, fruitful to understand to what extent environmental and economic security concerns are reflected in the EGD policy documents using our sample. Figure 2 plots the environmental and economic security score of the 40 policy documents used in the analysis, showing also the average sample score for each of these aspects (the blue dotted lines). It is, hence, the policies in the top right quadrant that stand out as commingling initiatives fostering economic and environmental security in the EU.

The Green Deal Industrial Plan is the policy with the second highest score for Economic Security and considerable above the sample mean regarding Environmental Security. It explicitly combines issues of economic security and environmental security by framing the urgent challenge of climate neutrality as a catalyst for new economic growth, aimed at securing the European Union’s industrial competitiveness and strategic autonomy in critical net-zero technologies. Its overarching aim to help the EU lead the way globally in the net-zero industrial age by massively increasing the technological development, manufacturing production, and clean energy addresses material issues both for environmental and economic security. In the same vein the European Industrial Strategy has the highest relevance score in the sample when it comes to Environmental Security and is among the ten top policy documents for Economic Security. It is noteworthy that, despite being a policy aimed to bolster industrial production, it exhibits a higher score for environmental rather than economic security. This can partly be attributed to the recent energy crises in the EU, which highlighted the need to integrate energy and green transition elements in regional investment and industrial strategies. The block’s focus, reflected in the Industrial Strategy, is to prioritize investments in clean energy to provide the best insurance against price shocks and strengthen competitiveness in the face of recent adversities.

The variability in coverage patterns suggests opportunities for policy learning and mainstreaming. Documents that successfully integrate multiple human security dimensions could serve as models for enhancing



Fig. 2. Economic and Environmental Security Scores

others. Looking at the relevance scores, there are 16 policies which report a higher than average score in more than 4 HS aspects (essentially 5 aspects as there is no policy with more aspects). The Clean Air Directive stands out as it also exhibits a score in the top quartile of the distribution in 4 HS aspects (Health, Personal, Political and Community Security). Mitigating GHG and particle emissions has direct benign health effects for individuals and can be viewed as enhancing disaster preparedness thus addressing health and personal security respectively. Having said that, the relevance with Community Security is not that straightforward, however our analysis reveals a score of 13.7%. This most probably indicates the positive impact on equality, as degraded environmental services disproportionately affect marginalized communities, urban areas and age groups. By formally operationalizing the initiative for restoring air quality it strengthens the institutional framework, reflected in the high correlation with Political Security (13.6%). In essence, the Clean Air Directive operates as a multifaceted guarantee of Human Security, recognizing that securing human life and health necessitates a robust legal framework that simultaneously protects the supporting natural environment, ensures economic stability by mitigating costs, and upholds the public's right to information and legal redress.

Finally, our analysis identifies potential policy coherence challenges where different documents addressing related issues exhibit divergent human security emphases. Enhancing coordination mechanisms and developing explicit human security impact assessment frameworks could strengthen overall policy coherence and ensure that sustainability transitions genuinely advance human security across all its dimensions. The EGD and broader EU policy corpus could benefit from applying a Human Security lens, whereby the needs of the individuals and especially vulnerable groups and marginalized place are considered in the policy designed process. Moreover, the analysis indicates that the synergies between HS aspects are yet to be fully leveraged. Integrating environmental security concerns in health, economic and technology initiatives is imperative to achieve inclusive economic growth and ensure that the digital revolution does not jeopardize environmental and socio-economic resilience.

4. Conclusion

This research proposes a novel semantic analysis method to systematically map HS Aspects onto policy documents supporting the European Green Deal. The results highlight relatively balanced coverage across all eight human security dimensions, with economic, food, and community security receiving slightly more emphasis than political, personal, and technological security. However, the higher variability in technological security coverage suggests opportunities for more systematic mainstreaming of digital security considerations.

The modest coverage of technological security across EGD policies warrants particular attention given digitalization’s growing importance for sustainability transitions. Future policy development should more explicitly address how digital infrastructure, data governance, algorithmic decision-making, and cybersecurity intersect with all human security dimensions, both harnessing technological opportunities and mitigating digital risks to vulnerable populations.

From a methodological standpoint, embedding-based approaches (Sentence-BERT) combined with carefully compiled JSON frameworks offer a robust tool for extracting thematic alignment beyond mere keyword overlap. The percentile-based coverage scoring ensures robust identification of substantive policy content while avoiding spurious matches. This methodology has broader applicability beyond the European Green Deal context, adaptable to national sustainability strategies, corporate ESG reports, international development programs, or other policy domains where comprehensive assessment of human security implications is desired.

Future work may involve cross-institutional assessments contrasting how HS is reflected across governance levels, linking coverage measures with quantitative indicators such as budgets and implementation outcomes, and extending the framework to analyze stakeholder consultations, parliamentary debates, and civil society responses.

Ultimately, the goal is to ensure that in pursuing sustainable development and climate neutrality, policymakers explicitly address the multi-layered security needs of individuals and communities. By making these connections explicit and measurable, our methodology contributes to more integrated, equity-oriented, and people-centered approaches to sustainability governance. The relatively balanced coverage identified suggests that the European Green Deal framework provides a solid foundation for comprehensive human security integration, with clear opportunities for enhancement through more systematic mainstreaming, particularly in the technological security domain.

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5. Appendix

Table 2. Human Security Aspects Coverage Across 40 EU Green Deal Policy Documents

Human Security Aspect	Mean Coverage (%)	Std Dev	Range (%)
Economic Security	14.0	0.9	12.0–16.4
Food Security	13.6	1.3	11.8–18.2
Community Security	13.2	0.7	11.7–14.7
Environmental Security	12.9	1.1	10.7–15.6
Health Security	12.8	0.9	11.0–14.3
Political Security	11.8	1.3	9.0–14.2
Personal Security	11.4	1.3	8.4–14.8
Technology Security	10.4	1.8	7.3–14.6

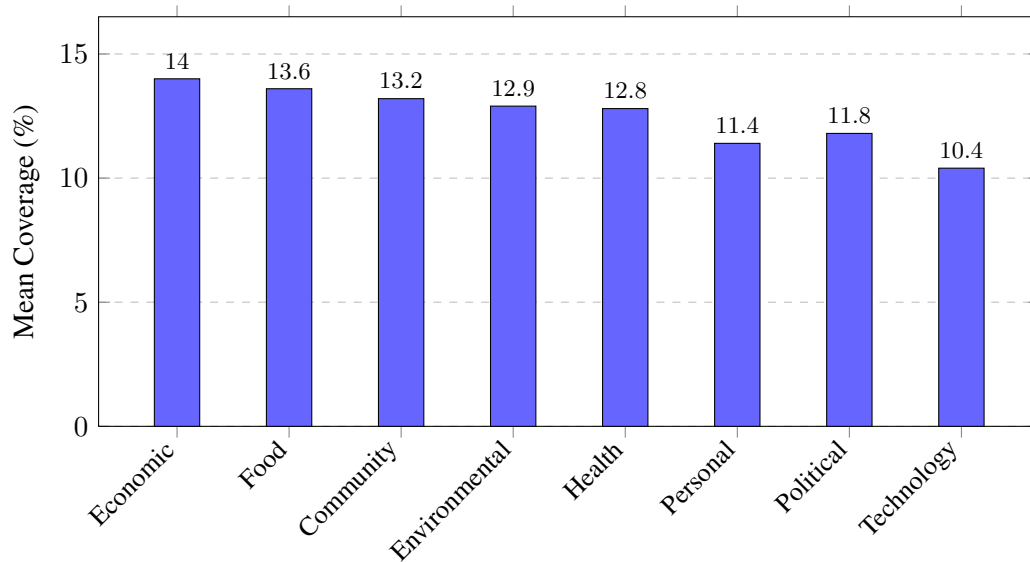


Fig. 3. Mean Coverage Scores of Human Security dimensions across 40 EU Green Deal policy documents. Economic Security shows highest coverage (14.0%) while Technology Security shows lowest (10.4%)

Table 3. Policy Codes and Acronyms

Policy Code	Policy Name	Policy Acronym
52020DC0098	Circular Economy Plan	CEP
52020DC0102	European Industrial Strategy	EIS
52020DC0299	EU Energy Integration Strategy	EUEIS
52020DC0380	EU Biodiversity 2030	EUB2030
52020DC0381	Farm to Fork Strategy	F2F
52020DC0575	Sustainable Growth Strategy 2021	SGS2021
52020DC0789	Smart Mobility Strategy	SMS
52020SC0178	2030 Climate Target Plan	2030CTP
52020SC0248	Sustainability in Chemicals	SC
52021DC0032	EU Financial System Reform	EUFSR
52021DC0188	EU Taxonomy & Finance Directive	EUTFD
52021DC0240	Sustainable Blue Economy	SBE
52021DC0573	New European Bauhaus Initiative	NEBI
52021DC0811	EU Urban Mobility Framework	EUUMF
52021DC0820	TEN-T Expansion	TENTE
52021PC0555	Effort Sharing Regulation Update	ESRU
52021SC0025	Climate Change Adaptation Strategy	CCAS
52021SC0065	Organic Action Plan	OAP
52021SC0141	Zero Pollution Plan	ZPP
52021SC0326	Anti-Deforestation & Soil Health Proposal	ADSHP
52022DC0108	REPowerEU Energy Plan	REPowerEU
52022DC0138	Energy Price Mitigation Options	EPMO
52022DC0140	Sustainable Products Standard	SPS
52022DC0360	Save Gas for Winter	SGW
52022PC0304	Nature Protection Regulation	NPR
52022PC0540	Water Quality Standards Directive	WQSD
52022PC0541	Urban Wastewater Treatment Directive	UWTD
52022PC0542	Clean Air Directive	CAD
52022SC0111	Industrial Emissions Modernization	IEM
52022SC0167	Nature Protection Working Document	NPWD
52023DC0062	Green Deal Industrial Plan	GDIP
52023DC0100	EU Fisheries Energy Transition	EUFET
52023DC0102	Marine Ecosystems Restoration Plan	MERP
52023DC0103	Fisheries Policy Communication	FPC
52023DC0440	Green Freight Transport	GFT
52023PC0148	EU Electricity Market Reform	EUEMR
52023PC0155	Goods Repair Rules Proposal	GRRP
52023PC0201	Agri-food Marketing Standards Revision	AMSR
52023PC0451	Circularity in Automotive Sector	CAS
52023SC0101	Energy Labelling Regulation Update	EULRU