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Original research article

Global gas flaring and energy justice: An empirical ethics analysis of stakeholder perspectives

Godwin O. Aigbe^{a,*}, Matthew Cotton^b, Lindsay C. Stringer^a

^a Department of Environment and Geography, Wentworth Way, University of York, Heslington, York YO10 5NG, United Kingdom

^b School of Social Sciences, Humanities and Law, Teesside University, Middlesbrough TS1 3JN, United Kingdom



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ABSTRACT

Global gas flaring harms human and non-human health and well-being while contributing to climate change. Flaring activity in the global oil and gas sector is a significant matter of energy justice – concerning the distribution of risks, benefits and harms, recognition of rights, and decision-making influence within gas-flaring-affected communities. This mixed method empirical ethical analysis of gas flaring and energy justice combines Q-methodology and stakeholder interviews with representatives of 14 gas-flaring-affected countries (n = 35) to evaluate the context-sensitivity of distributive, procedural, recognition, and cosmopolitan justice principles to gas-flaring governance. Four dominant normative perspectives emerge around this topic. These perspectives concern: a) government-led zero flaring policy; b) multi-scalar economic governance; c) business responsibility and social license; and d) localism and community empowerment. We find that: first, there is strong stakeholder support for zero-flaring globally. Second, coordinated multi-scalar governance from international-national-local regulatory authorities is desired to protect marginalised communities. Third, egalitarian rights-based approaches are prioritised over utilitarian approaches in planning for oil and gas extraction. Fourth, business responsibility necessitates transparent communication of flaring activities and impacts and the Polluter Pays Principle of environmental redress to affected communities. Finally, stakeholder disagreement centres upon the practical mechanisms to achieve just outcomes - including compensation, the role of local authorities, regulatory agencies, Environmental Impact Assessment, and efforts to tackle rent-seeking and corruption. We conclude that further stakeholder engagement is needed on the implementation processes for gas flaring elimination, rather than the goal itself, through carefully facilitated dialogue and negotiation.

1. Introduction

Gas availability in world markets has recently become an acute energy security issue, in part due to the re-opening of the global economy following the Covid-19 downturn and Russia's invasion of neighbouring Ukraine in February 2022. Growing pressure on natural gas resources and gas transmission flows exacerbates global concern over gas sustainability and the waste produced through flaring. Gas flaring is the disposal of excess natural gas by burning it in the open air. It occurs in chemical plants, natural gas processing plants, offshore and gas rigs, oil and gas extraction sites and petroleum refineries. Flaring occurs for several reasons, including a lack of market access or transport infrastructure for gas and the prohibitive costs associated with transporting gas from geographically remote regions. Other reasons include depressurising gas extraction equipment to manage unpredictable and

large pressure variations by reducing explosion risks and legal ambiguity over how associated gas should be processed [1–4]. Collectively, these factors make gas flaring a common industrial practice in the oil and gas sector. However, it is increasingly recognised in policy and academic networks that flaring represents a waste of natural resources and creates a significant environmental burden locally and globally. Specifically, flaring bears a range of social, health and ecological risks and economic externalities in communities that host oil and gas extraction [4]. Associated adverse impacts of flaring activity include respiratory and cardiovascular health impacts from particulate matter, skin cancers and lesions via dermal exposure and the ingestion of contaminated water, which can alter the stomach pH and cause ulcers [5,6]. The broader environmental health implications of flaring for climate change and localised air pollution from CH₄ and black carbon [7–13] affect air and water quality, ecosystem services, biodiversity, and crop production

* Corresponding author.

E-mail address: goa507@york.ac.uk (G.O. Aigbe).

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[14,15] making this a significant issue of environmental and energy justice.

The seven countries with the highest shares of gas flaring currently produce 40 % of annual global oil and gas and account for 65 % of total global flaring [16], though reduced gas flaring may only have a short-term effect in reducing the carbon intensity of fossil-fuel energy generation, acting as a “bridge fuel” when substituting oil or coal [17]. As such, natural gas remains the preferred option among major electricity providers [18,19]. Al-Hamed and Dincer [20] argue for natural gas use in rail transportation to ameliorate the environmental impacts and maximise the economic advantages of switching from diesel fuel. Consequently, as Gillesen et al. [21] note, numerous commentators have argued in favour of natural gas as a bridge or transition fuel to provide short-term environmental benefits over other fossil fuels while maintaining energy security and affordability benefits. Despite this, the carbon intensity of natural gas remains considerably higher than equivalent renewable alternatives.

Changing energy geopolitics, gas demand, and production are mediated by processes of global governance, including that concerning climate change mitigation. Notable among global governance measures are the Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) [21], reinforced at COP 26 in 2021, and voluntary governance arrangements, including the partnership model espoused in the World Bank Global Gas Flaring Reduction Initiative [22]. Despite concerted global action to end gas flaring, many nations, particularly in the Global South, lack the capacity and political will to implement such changes. There is often a lack of viable markets for excess gas production, a lack of operational policies and regulatory commitments to gas flaring reduction, and a generally permissive attitude towards flaring as long as gas (and associated tax) revenues continue to flow [23–26]. However, it is important to note that gas waste through flaring is a significant economic development issue in its own right. The World Bank/GGFR data [27] estimated that 142 bcm of natural gas flared in 2020 alone is sufficient to power sub-Saharan Africa. The top ten countries’ diffusion of gas flaring shows relatively consistent flare volumes over 2016–2020 (see Table A1). Reducing gas waste through flaring would be a ‘quick win’ for climate action and social development in the short term when implemented alongside other structural energy system decarbonisation measures.

International policy responses to global gas flaring activities also increasingly emphasise *just* sustainable transition actions, specifically in countries and communities dependent on domestic oil and gas production for economic and social development. The combination of gas flaring’s local and global environmental and geopolitical impacts requires greater systems-level thinking about energy production, marketing and consumption, and infrastructure. It also requires a greater understanding of diverse stakeholder perspectives and stronger legal and regulatory mechanisms to ensure oil and gas sector compliance with flaring reduction measures. There is, therefore, an urgent need to research the prospective benefits, justice and inequality dimensions associated with flaring to inform the design of “good governance” mechanisms towards flaring practices within the industry. As such, we aim to provide an *empirical ethical* approach (described below) to assess and analyse stakeholder perspectives relating to principles of energy justice and challenges stemming from social-environmental harms associated with global gas flaring. In doing so, we provide important normative insight that could inform the design of future gas flaring policies.

2. Energy justice in global gas flaring

The governance of gas flaring is a matter of local and global energy justice. Conceptually, energy justice is a relatively new ‘twin’ discipline of the established field of environmental justice studies that applies ethical, political, and spatial analysis to the normative evaluation of

energy systems. Energy justice evaluation commonly assesses the interrelated socio-technical dimensions of energy production and use. Energy justice analysis has been applied to policy frameworks, production, transmission and consumption systems, demand management, social movements and activism, security of energy supply, geopolitical relationships, market access, post-colonial social development, extractivism, and responses to global climate emergencies [29]. We posit that energy justice falls within the purview of *empirical ethics*, by which scholars integrate moral theory and empirical data to reach a normative conclusion regarding specific social practices [28]. Empirical ethics regarding energy justice and global gas flaring necessitate social science research into normative stakeholder perspectives on gas flaring justice principles, the impacts upon affected communities, and insight into policy actions across the different country contexts in which flaring occurs.

Though the *justice* framing of socio-technical system evaluation is diversely theorised across applied philosophy, geography and science and technology studies [29–31], a typical ‘top-level’ framing of energy justice reveals four categories of normative principles that we subject to empirical analysis:

1. *Distributive justice*: concerning spatial, governance, temporal and scalar patterning of benefits and burdens
2. *Procedural justice*: concerning due process, fair treatment of individuals and host communities, and opportunities for public participation in decision-making
3. *Recognition justice*: concerning how decision-making authorities value and respect the identities of vulnerable and marginalised groups, and how alternative voices, identities, and inclusive representation are managed within environmental governance processes; and
4. *Cosmopolitan justice*: concerning global externalities from associated greenhouse gas (GHG) emissions, pollution, and health impacts, and how these impact the human rights of affected peoples (Table 1).

Social science case study analyses of gas flaring have largely been place-based and predominantly in the USA [32–35] and Niger Delta [36–38]. These studies have revealed the importance of rights, fairness, well-being, and participation in governance in ensuring just decision-making outcomes for affected communities. Building from these, we take an expanded and abstracted approach to the empirical ethics analysis in this study to focus on justice and inequality issues that arise as decision-making authorities seek to improve gas resources efficiency or phase them out to meet energy transition goals. Inevitably, when questions of normative evaluation are expressed by diverse stakeholder representatives, competing judgements and differing underlying guiding principles will lead to different policy choices and outcomes. Understanding the patterns of consensus and disagreement surrounding the justice issues raised is thus an important component in developing fair and inclusive gas flaring policies that are sensitive to stakeholder values and concerns and thus ensure stakeholder ‘buy-in’ to proposed policy and environmental management solutions.

Our empirical ethical analysis aims to improve the context-sensitivity of energy justice principles [39] to gas flaring policy and practice by drawing upon diverse perspectives from stakeholders from 14 different gas-flaring-affected countries. We operationalise established energy justice principles as framing mechanisms to better understand the discourses of gas flaring governance from the global perspectives of gas flaring stakeholders. Of note is our innovative use of Q-methodology to establish the context-sensitivity and heterogeneity of discourses of energy justice principles surrounding gas flaring governance. Q-method is an exploratory method used to define emergent perspectives around a topic of interest. It neither tests its participants nor imposes a priori meanings, thus unsuited to hypothesis testing. As such, our research question to which the Q-method is applied is: What are the emergent perspectives on energy justice and global gas flaring

Table 1

A conceptualization of energy justice components and applications to gas flaring.

	Definition and application
<i>Distributive justice</i>	Distributive justice concerns the spatial/scalar sharing of goods (e.g., natural gas resources) and “bads” (environmental harms and health risks from gas flaring) or equitable or effective distribution of social and economic benefits and burdens from natural gas resources across communities or generations. <i>Gas flaring-specific concerns:</i> Benefits and burdens sharing of natural gas exploration, extraction and use, equity of access to green space, compensation to host communities, equal availability of energy (electricity), access to clean air and water, spatial patterning of gas flaring pollution risks, exposure to natural disasters and climate change impacts.
<i>Procedural justice</i>	Procedural justice concerns decision-making, principally who is involved and has influence in decisions, access to information about environmental risks and burdens, involvement in policy design and redress through the policy-making process, and adherence to due process and fair treatment of individuals/groups under the law. <i>Gas flaring-specific concerns:</i> Planning processes, regulatory practices, environmental rights, due process, public participation, deliberative mechanisms of decision-making.
<i>Recognition justice</i>	Recognition justice concerns who is accorded respect and how individual and community identities, social values and cultural practices are respected and valued. Inclusion of diverse, vulnerable, marginalised, poor, or under-represented or misrepresented peoples and demographic groups in a society. <i>Gas flaring-specific concerns:</i> Impacts of gas flaring on vulnerable groups, particularly minorities, people of colour, or indigenous people within gas flaring host communities, use of appropriate language in environmental communication, respect for mechanisms of self-governance and community identity.
<i>Cosmopolitan justice</i>	Cosmopolitan justice concerns universal respect for individual human rights irrespective of protected characteristics or cultural identity. Alternatively, it concerns the global scope of justice demanding adherence to general principles, including respect for civil and democratic rights and substantial socio-economic egalitarianism. <i>Gas flaring-specific concerns:</i> Negative market externalities that are produced or distributed globally. For example, releasing toxic pollutants such as sulphur dioxide and NOx can lead to acid rain, low-level ozone, and smog formation. GHG emissions (including CO ₂) contribute to climate change.

Source: Adapted from [40–43].

governance, and how can consensus and conflict between competing perspectives help to inform fair and inclusive gas flaring policies?

3. Methodology

Q-method is a mixed-method social research approach that combines factor analysis with qualitative interpretation to elicit factors that correlate to scores assigned to a set of pre-defined statements [44–46]. Q-method provides elements of structured statistical and interpretive qualitative analysis [47,48] useful for exploring respondents’ subjective attitudinal perspectives and establishing conventional viewpoints around a controversial topic. As such, it has grown in popularity in recent years in environmental governance research [49–52] and has been used to delineate stakeholder perspectives concerning controversial environmental debates [44] and explore complex stakeholder value dimensions within such debates [49]. We employ it here as a methodological innovation in *empirical ethics* [50] – a means through which individual stakeholders can reflect upon the energy justice dimensions of gas flaring operations and provide statistical rigour in an evaluation of the patterning of moral judgements made by such stakeholders throughout the Q-sorting and exit interview process.

Methodologically, we follow established protocols for Q-method study detailed in [51,52], deriving six primary steps for Q-method analysis:

- (1) Develop the concourse
- (2) Develop the Q-set
- (3) Recruit the P-set
- (4) Q-sorting of statements
- (5) Exit interview
- (6) Statistical and interpretive data analysis [53].

Each of these is discussed below.

1) *Develop the concourse.* The “concourse” refers to a broad collection of statements, termed Q-items, that encapsulates the nature of the public discourse on the topic under investigation. We drew 55 initial Q-items from preliminary interviews, consultations and expert surveys, and qualitative interview data (see [54]). Interviews were conducted with 7 specialists (4 representatives from environmental NGOs, advocacy groups, and 3 environmental campaigners living in gas flaring host communities). Interviews were carried out via zoom/telephone and transcribed. Expert survey was conducted via email. Data from the interviews were analysed using NVivo12 software. The expert survey targeted participants with a PhD in oil and gas and related fields and policy experts. 59 experts were contacted through e-mail, and 23 completed and returned surveys.

Q-items drawn from primary interviews were combined with statements drawn from secondary data extracted from published articles related to gas flaring and environmental/energy justice literature, as shown in Table A2. Articles were obtained through an internet search and selected by combining search terms with the subject heading “gas flaring and environmental/energy justice” (Table A3). 393 relevant articles were analysed and selected from gas flaring and environmental/energy justice literature.

2) *Develop the Q-set.* The draft concourse drawn from primary and secondary qualitative data was analysed thematically using NVivo12 software. Thematic analysis was used to pre-structure the energy justice components presented in Table 1, leading to the characterisation of the concourse and selected Q-statements in Table 2 and the final presentation provided in Table 3. This structure was not revealed to the respondents but was exclusively intended for the researchers. Draft statements were modified from their original sources to reflect the study’s aim and objectives while retaining a balance of anti-gas flaring, pro-flaring, and neutral perspectives. The initial draft of 55 statements was piloted with 3 experts and researchers and then redrafted into a smaller 36-statement Q-set for manageability, e.g., [55,56] before being further checked independently by 2 academics and industry experts. The final version was administered online using Q-method software (<https://qmethodsoftware.com>). All the Q-sort rankings were conducted between February and March 2022.

3) *Recruit the P-set.* The P-set in a Q-method study represents the observations, while the Q-set represents the variables [57]. The P-set (where P means “people”) is selected to represent a wide diversity of viewpoints among informed and interested stakeholders, much in the same manner as a qualitative interview study (see Table 4 for a list of participants and their roles). For this study, the P-set was selected based on participants’ knowledge, interest, and participation in the public debate concerning gas flaring, environmental/energy justice, climate change, transition, and other environmental issues. They included those with professional backgrounds in oil and gas, alongside those with a PhD in oil and gas and related fields, academics, law and governance, health and safety, journalism, software and computer engineering, citizen stakeholders living in gas flaring host communities, environmental advisors/consultants, and company directors. Participant input was requested through LinkedIn, email, and phone contacts. 100 were contacted through a purposive-snowball sampling approach, while stakeholders who agreed to participate and those that declined were also asked to refer other suitable participants from within their professional and individual networks. A final P-set of 35 produced the usable Q-sorts (response rate = 35 %, average time of completion 28 min), from which 34 responded to the exit interview. While 8 out of the 100 P-set were

Table 2
Characterisation of the discourse and selected Q-statement.

Overarching theme	Issue (Q-set statement number)
Distributive justice	<ul style="list-style-type: none"> • Communities affected by gas flaring should be compensated with subsidised electricity S3. • Gas flaring is a separate issue from energy poverty, and the two should not be confused S4. • The benefits and burdens of gas flaring should be shared fairly between rich and poor communities S5. • Governments should subsidise oil and gas production S6. • Current environmental protections from oil and gas flaring sufficiently balance ecological costs and economic benefits S7. • A thriving oil and gas sector is essential for the economic vitality of rural gas flaring host communities S10. • Action taken on rent-seeking and corruption should be the first step in tackling gas flaring S12. • Gas flaring is a problem when the industry is dominated by international capital, and oil and gas companies extract the value of the gas to another country S16. • Oil and gas companies should voluntarily adopt the Polluter Pays Principle: offering compensation and funding for environmental remediation S30.
Procedural justice	<ul style="list-style-type: none"> • To tackle gas flaring, we should improve transparency and industry accountability in the global oil and gas sector S1. • The environmental impacts of oil and gas flaring are experienced locally and should therefore be managed by local authorities S11. • Voluntary disclosure of gas flaring emissions by oil and gas companies is desirable S13. • All data on gas flaring emissions, health impacts, and distribution patterns should be made publicly available S17. • Greater levels of public money should be spent regulating and enforcing gas flaring control measures S18. • Host communities' concerns about gas flaring impacts should be integrated into governments' oil and gas exploration and development decisions S20. • Governments should set up an independent community watchdog group and an advisory group of community leaders to examine, monitor and review government regulatory agencies and the activities of international oil companies S21. • Oil and gas companies should be mandated to complete a full Environmental Impact Assessment (EIA) for any activities where gas flaring will occur S24. • Governments should lead decisions on oil and gas flaring in the national interest S25. • State and local government agencies and officials with public input should lead gas flaring decisions S22. • Local communities should have the power to stop oil and gas extraction in their local communities if they do not want it to happen S23. • A national regulatory agency should make decisions on managing gas flaring environmental impacts S26. • More should be done to highlight the problem of gas flaring to raise awareness and build collective action for regulation changes S33. • Global gas flaring produces avoidable emissions, and legislation should stop such practices S35.
Recognition justice	<ul style="list-style-type: none"> • Oil and gas companies should build long-term community trust in the locations where they extract natural resources S19. • Host communities' concerns about gas flaring impacts should be integrated into governments' oil and gas exploration and development decisions S20. • Governments need to protect communities from feeling dispossessed of their land and livelihoods S28.
Cosmopolitan justice	<ul style="list-style-type: none"> • It is acceptable for gas flaring to take place in areas of low population density S27.

Table 2 (continued)

Overarching theme	Issue (Q-set statement number)
	<ul style="list-style-type: none"> • Heavy gas flaring nations should compensate neighbouring countries for environmental impacts caused by transboundary pollution S29. • Governments should accept responsibility for gas flaring impacts, even if privately owned industries cause them S31. • All countries across the world should aim for zero gas flaring S34.
Support/non-support for gas flaring	<ul style="list-style-type: none"> • We should reduce the amount of waste gas in order to improve profitability in extraction S2. • Current environmental protections from oil and gas flaring sufficiently balance ecological costs and economic benefits S7. • Energy generation using natural gas is positive for the environment S8. • Revenue generation from oil and gas production outweighs the environmental cost S9. • A thriving oil and gas sector is essential for the economic vitality of rural gas flaring host communities S10. • Gas flaring is simply a routine practice in the oil and gas industry S14. • The dangers of gas flaring are exaggerated S15. • The health and environmental impacts on oil and gas flaring communities are shameful S32. • Gas flaring should be allowed as it improves safety for oil and gas workers by reducing the risk of explosion in pipelines and other infrastructure S36.

incomplete and unusable data, 57 declined to participate due to personal choices. As is standard in Q-method studies, the P-set sample size need not be large [46]. However, as shown in Table 4, the P-set represents heterogeneous perspectives across diverse stakeholder representation (both in terms of geographic spread and sectoral background), which is generally preferable to proportionality [45].

4) *Q-sorting of statements.* Q-sorting is the process by which each respondent evaluates the Q-sort by assigning a score to each opinion statement to show the extent of agreement and disagreement, leading to a matrix of cross-correlations between all Q-sorts [46]. In a manner similar to [58,59], we conducted expert interviews with Q-sort participants to validate and contextualise the statement sorting process and to provide additional rich descriptions necessary for the qualitative interpretation of the emergent perspectives. To acquaint participants with the online Q method software and the 36 statements, participants were forwarded a tutorial video to watch the process of completing the Q-Sort before beginning the Q-Sort, offering a two-step sorting process. Participants were then instructed to read the 36 statements carefully and then place the individual items into a grid format from -5 (least like my perspective) to +5 (most like my perspective) with a quasi-normal distribution pattern (see Fig. 1). The sorting grid is shaped symmetrically around 0, as shown below:

5) *Exit interview.* Respondents were asked to reflect upon their statement placement in the grid to provide further qualitative validity to constructing perspectives in the analysis stage. Note that 1 respondent out of 35 P-set that produced the usable Q-sorts participated in the survey but declined to respond to the exit interview questions.

6) *Analysis.* Q-method software (<https://qmethodssoftware.com>) was used for the data analysis. Q-method analysis generates factors: a weighted average of Q-sorts representing an archetypical shared perspective of respondents [60]. Respondents who share similar views are extracted to define individual factors. The factors and the associated ranking of statements show a typical way a respondent with a similar perspective would rank a statement. In terms of statistical analysis, first, Pearson correlation was applied to extract a correlation matrix between all the Q-sorts. Second, Principal Component Analysis (PCA) was used for factor extraction, which, unlike Centroid Analysis, in PCA, the number of factors was automatically chosen and reflected in the

Table 3
Factor loadings of Q-statements.

No Statement	Factors			
	1	2	3	4
1. To tackle gas flaring, we should improve transparency and industry accountability in the global oil and gas sector.	0	+2	+5	+5
2. We should reduce the amount of waste gas in order to improve profitability in extraction.	-1	+3	+2	+1
3. Communities affected by gas flaring should be compensated with subsidised electricity.	-1	+3	-4	+4
4. Gas flaring is a separate issue from energy poverty, and the two should not be confused.	-1	0	-1	0
5. The benefits and burdens of gas flaring should be shared fairly between rich and poor communities.	-2	+2	-2	+3
6. Governments should subsidise oil and gas production.	-3	0	-3	-2
7. Current environmental protections from oil and gas flaring sufficiently balance ecological costs and economic benefits.	-3	+1	-1	-4
8. Energy generation using natural gas is positive for the environment.	-2	+2	+2	-2
9. Revenue generation from oil and gas production outweighs the environmental cost.	-3	0	-5	-5
10. A thriving oil and gas sector is essential for the economic vitality of rural gas flaring host communities.	-1	-4	0	-3
11. The environmental impacts of oil and gas flaring are experienced locally and should therefore be managed by local authorities.	-2	-1	-4	-1
12. Action taken on rent-seeking and corruption should be the first step in tackling gas flaring.	-2	-3	+1	-1
13. Voluntary disclosure of gas flaring emissions by oil and gas companies is desirable.	0	+1	+1	+1
14. Gas flaring is simply a routine practice in the oil and gas industry.	-4	0	-2	0
15. The dangers of gas flaring are exaggerated.	-5	+1	-2	-4
16. Gas flaring is a problem when the industry is dominated by international capital, and oil and gas companies extract the value of the gas to another country.	0	-1	-1	-2
17. All data on gas flaring emissions, health impacts and distribution patterns should be made publicly available.	+1	0	+3	+1
18. Greater levels of public money should be spent regulating and enforcing gas flaring control measures.	0	+1	-3	0
19. Oil and gas companies should build long-term community trust in the locations where they extract natural resources.	+2	0	+4	+3
20. Host communities' concerns about gas flaring impacts should be integrated into governments' oil and gas exploration and development decisions.	+1	+1	+2	+2
21. Governments should set up an independent community watchdog group and an advisory group of community leaders to examine, monitor and review government regulatory agencies and the activities of international oil companies.	+1	-3	+1	+2
22. State and local government agencies and officials with public input should lead gas-flaring decisions.	0	-1	0	-1
23. Local communities should have the power to stop oil and gas extraction in their local communities if they do not want it to happen.	0	-2	-2	+3
24. Oil and gas companies should be mandated to complete a full Environmental Impact Assessment (EIA) for any activities where gas flaring will occur.	+2	-3	+3	+4
25. Governments should lead decisions on oil and gas flaring in the national interest.	+1	-2	+3	-1
26. A national regulatory agency should make decisions on managing gas flaring environmental impacts.	+2	+3	0	-1
27. It is acceptable for gas flaring to take place in areas of low population density.	-4	-1	-1	-2
28. Governments need to protect communities from feeling dispossessed of their land and livelihoods.	+3	-2	+2	+2
29. Heavy gas flaring nations should compensate neighbouring countries for environmental impacts caused by transboundary pollution.	+1	-1	+1	0

Table 3 (continued)

No Statement	Factors			
	1	2	3	4
30. Oil and gas companies should voluntarily adopt the Polluter Pays Principle: offering compensation and funding for environmental remediation.	+2	+2	+4	+1
31. Governments should accept responsibility for gas flaring impacts, even if privately owned industries cause them.	+3	-2	-1	+1
32. The health and environmental impacts on oil and gas flaring communities are shameful.	+3	-4	-3	+2
33. More should be done to highlight the problem of gas flaring to raise awareness and build collective action for regulation changes.	+4	+4	0	0
34. All countries across the world should aim for zero gas flaring.	+5	+4	0	0
35. Global gas flaring produces avoidable emissions, and legislation should stop such practices.	+4	+5	+1	-3
36. Gas flaring should be allowed as it improves safety for oil and gas workers by reducing the risk of explosion in pipelines and other infrastructure.	-1	-5	0	-3

“extracted factors” as unrotated factor loadings of all Q-sorts (see Table A4). Third, factors with Eigenvalues >1.00 are considered statistically significant. Based on an evaluation of the number of participants loading on all factors, distinguishing statements, Eigenvalues, and assessment of the scree plot, four factors were selected and subjected to orthogonal (Varimax) rotation (see Fig. A1). The exit interview data were analysed thematically using NVivo12 software, and this fed into the qualitative interpretation of the emergent perspectives.

4. Results and perspectives interpretation

Four dominant perspectives on energy justice and global gas flaring emerged (Tables 3 and 4), accounting for 58 % of the cumulative variance. Factor arrays explaining >50 % of cumulative variance are favoured in Q-method studies [61]. References to important Q-statements, e.g., S20, are included in the various descriptions as the narratives are constructed from the Q-statements.

Although there is no conventional number of factors to retain and utilise [52], there are two most widely used methods to determine the number of factors to extract:

1. The number with Eigenvalues >1.00
2. Factors with at least two significant loadings ([45], pp. 222–223).

For this research, all eight unrotated factors (see Table A4 and Fig. A1) met the above conditions, as suggested by [45]. As the Q study relies on the researcher’s familiarity with the subject to make the judgement and their skills, we rotated and retained the first four Eigenvalues, which explain 58 % of the variance.

As both the statement value and z scores indicate the ranking of statements in each factor, the factor’s composite Q-sort and difference scores reveal the salient statements requiring specific attention when describing and interpreting the various factors [48,62,63]. To establish the boundaries of emergent perspectives, we followed established research practices in environmental governance research [64–66] analysing:

1. Statement values beginning with the highest scores (+5) and lowest (-5) scores for each factor, working “inwards” towards zero.
2. The significance of each statement’s z-score (the top positive z-scores and bottom negative z-scores)
3. Explanations and context drawn from the exit interview.

Interpreting the four distinctive composite Q-sorts with elaborations by respondents enabled us to identify four perspectives, labelled A–D,

Table 4
Participant details and factor loadings for each Q-sort.

Participant-country of origin/domicile	Factor 1	Factor 2	Factor 3	Factor 4
<i>Academics/industry experts</i>				
1. Academics/Citizen stakeholder (HOD Science/Physics)-Qatar/UK/Nigeria	0.72335*	-0.08772	0.08478	-0.0781
2. Academics (Lecturer & Environmental Consultant)-Nigeria	0.67589*	-0.15055	0.02629	0.08007
3. Academics (Associate Professor)- Norway	0.44256*	-0.26774	0.19206	0.24521
4. Academics (Lecturer/Consultant Geologist)-Nigeria	0.13318	0.32201	0.62467*	0.27804
<i>Industry stakeholders/scientific</i>				
5. Oil & Gas industry (Head of Offshore HSE)-France	0.6819*	0.33425	-0.05702	0.22109
6. Oil & Gas industry (Senior Operations Supervisor)-Nigeria	0.68824*	0.09426	0.39133	0.0095
7. Oil & Gas industry (Engineer and Researcher)-Netherlands	0.52339*	-0.07727	0.27149	-0.02693
8. Subsurface Consultancy (Chief Production Technologist)-Netherlands	0.73184*	0.02908	0.40174	-0.113
9. Oil & Gas industry- (Petrojet, Cairo) (Senior Process Engr)-Egypt	0.65488*	0.17031	0.47785	0.24522
10. Oil & Gas industry (Deputy General Manager) also from gas flaring host community (France/UK/Nigeria/Angola)	-0.18743	0.73774*	0.2152	0.34751
11. Oil & Gas industry (Environmental Consultant BTGap, L.L.C.)-USA	0.19564	0.01051	0.71622*	0.03153
12. Oil & Gas industry (HSE Manager)-France/Nigeria	0.09295	-0.07199	0.35172*	0.13729
13. Oil & Gas industry Technical Advisor-USA/Nigeria	-0.03891	0.36997	0.51386*	0.12232
14. Mexican Energy Consultancy (Natural Gas Analyst)-Mexico	0.66676*	0.07393	0.55255	0.34319
<i>Directors, regulatory, governmental, and NGO stakeholders</i>				
15. Environmental-Ecosystem Pipeline (Regional Manager)-UK	0.69507*	0.27266	0.19908	0.30453
16. Statistics Canada (Environmental Specialist)-Canada	0.83497*	-0.16198	0.22799	-0.1806

Table 4 (continued)

Participant-country of origin/domicile	Factor 1	Factor 2	Factor 3	Factor 4
17. Energy & Environmental Management (CEO& President)-USA	0.17984	0.74062*	0.0689	-0.1641
18. Energy & Environmental Management (Senior Energy Resource and Regulatory Advisor)-Canada	0.01932	-0.24368	0.72961*	0.03632
19. Sustainability & Environmental Management (Environmental Advisor)-UK	0.10111	-0.01047	0.1084	0.81027*
20. Environmental Defense Fund (Senior Director, Regulatory & Legislative Affairs)-USA	0.78046*	0.1472	-0.03698	0.24198
21. African Development Bank (Director)-Côte d'Ivoire	0.68517*	0.45602	0.08175	0.22511
22. Regulatory/NGO (Senior Policy Campaigner/Analyst)-USA	0.77995*	0.09321	0.00011	0.3345
23. Law & Governance/Public (Policy Legal Consultant)-Nigeria	0.67046*	0.28055	0.27826	0.42597
24. Law and Governance (Principal Legal Consultant)	0.2107	0.09568	0.50459*	-0.01311
25. Renewable Energy (Legal Consultant/Policy Analyst) -Nigeria	0.32222	-0.1365	0.12792	0.73029*
26. NGO (Entrepreneur and an Engineer)-Nigeria	0.65989*	0.0963	0.28754	0.1175
<i>Citizen stakeholders</i>				
27. Citizen stakeholder (Software Engineer)-USA/Nigeria	0.83426*	0.14896	0.04936	0.3245
28. Citizen stakeholder (Rector)-Nigeria	0.43899*	-0.18241	0.34802	0.06814
<i>Others</i>				
29. Journalism and Media (Journalist)-UK/Iran	0.16135	0.13938	0.06422	0.7655*
30. Unknown	0.5571*	0.33652	0.07411	0.40713
31. Unknown	0.06581	0.74441*	-0.1063	-0.19574
<i>Unflagged</i>				
32. Academics (Professor)-Environmental Science from gas	0.41417	0.28597	0.40323	0.45962

(continued on next page)

Table 4 (continued)

Participant-country of origin/domicile	Factor 1	Factor 2	Factor 3	Factor 4
flaring state in the Niger Delta				
33. Researcher-Canada	-0.0092	-0.11997	0.07274	0.27188
34. Director at Carbon Counts-Germany	0.42579	-0.22814	0.28691	0.22932
35. Academics-Senior Lecturer-Nigeria	0.32347	0.28682	0.47529	0.35254
Eigenvalues	12.66465	2.98467	2.49626	2.14835
% Exp Var.	36	9	7	6
Cumulative % Exp. Var.	36	45	52	58
No. of loadings	19	3	6	3

Z-score numbers marked in **bold** (*) represent defining sorts for that factor ($p < 0.05$).

each given a descriptive moniker to summarise its key features.

- A. **Government-led zero-flaring policy**
- B. **Multi-scalar economic governance**
- C. **Business responsibility and social license to operate**
- D. **Localism and community empowerment**

As is common with Q-method studies, we make no claims for generalisability to broader populations within the statistical analysis. Instead, the four perspectives explain the likely patterns of responses that might emerge within and between diverse stakeholder groups. Notably, there is considerable diversity in perspective shown across the nominally identified stakeholder categories shown in Table 4. Perspective A is correlated with all industry stakeholders, citizen-stakeholders from gas flaring host communities, academics, and people with a higher education and training in environment and related fields ($n = 19$). Perspective B is highly correlated with industry stakeholders and one non-affiliated citizen stakeholder living in a gas flaring host community ($n = 3$). Perspective C is correlated with regulatory and technical advisors, legal and environmental consultants, and ordinary citizens ($n = 6$). Perspective D is correlated with one citizen-stakeholder from a gas flaring host community, legal/renewable energy, and environmental consultants ($n = 3$). Given the number of stakeholders loading on Perspective A and the clear drop between factors 1 and 2 on the scree plot (Fig. A1), we infer the clear dominance of Perspective A among our respondents and potentially among a broader network of stakeholder voices. References to the characterisation of the concourse and selected Q-statements are included in Table 2.

4.1. Government-led zero flaring (perspective A)

Perspective A is characterised by support for a government-driven ban on gas flaring, grounded in cosmopolitan, procedural, and distributive justice considerations. The stance on ending gas flaring is unequivocal. As respondent 24 stated in the exit interview:

“The issues that stood out for me are those that try to elucidate action by the government, oil prospecting companies and regulatory bodies on mitigating global gas flaring to a zero level”.

The defining statements S34, S33, and S35*¹ for this perspective were positively loaded, and statements S15*, S14 and S27 were negatively loaded. The defining aim for global zero gas flaring S34 is driven by the desire for greater outreach and awareness-raising of the core social and environmental impacts of flaring. This perspective is framed around

building a coalition of interest and collective action towards regulatory change S33 and legislative practices to actively halt emissions S35*. There is a strong sense of the scale of negative gas flaring impacts and a belief that such impacts are not being exaggerated or distorted through public perception S15*. Rather, the impacts are construed as shameful S32*, and hence should no longer be routine practice in the oil and gas industry S14. Notably, within this perspective, the role of government is clearly emphasised. There is little support for a ‘good governance’ model of responsible flaring activity S1, nor providing local community involvement in decision-making S23 or compensatory benefits S3*. Instead, advocates of perspective A support a top-down ban or moratorium on flaring, thus removing the need for local-scale community procedural justice mechanisms.

We find that the justification for the zero-flaring stance is grounded in *egalitarian* conceptions of cosmopolitan justice. Proponents of this perspective are not persuaded by business-as-usual justifications, such as siting flaring activities in areas of low population density S27 to protect worker safety S36 or to reduce waste gas and improve profitability in extraction S2*. Across the statement sorting and exit interviews, this perspective is characterised by strong support for a ban on flaring. It also emphasises that all other ameliorative mechanisms, such as decision-making or compensation to the host communities that might alleviate energy injustice from flaring, are unnecessary or undesirable. Thus, according to this perspective, the only solution is a zero-flaring policy platform.

4.2. Multi-scalar economic governance (perspective B)

Perspective B is characterised by the desire for multi-scalar governance and economic redress to gas flaring injustice. There is a strong desire for a global zero-flaring policy S34, which should be achieved through global governance mechanisms S35*, such as international treaties and government monitoring of progress towards net zero-flaring. There is a strong commitment by proponents of this perspective towards gas flaring governance at global and national levels, primarily through technocratic means S26*, i.e., greater reliance upon environmental management expertise to achieve just outcomes for communities. There was a rejection of broadly normative evaluations of flaring. For example, there was little support for the idea that gas flaring is a shameful practice S32*, despite a general lack of support for flaring overall as a routine practice S36. As respondent 2 described:

“The oil and gas business is necessary for the economic growth of the world. It can, however, be done more responsibly. The industrialised western world is driving the climate agenda while the developing countries in Africa and Asia need the oil and gas to grow and become fully industrialised”.

At local and regional scales, the picture is more complicated. There is strong support for compensation to communities through, for example, subsidised electricity as a distributive redress to environmental injustice S3*. This is partly because oil and gas are not seen as economically beneficial to the communities that support it as shown in S10, and proponents of this perspective remain equivocal about broader government subsidies of the oil and gas industry S6. As respondent 17 described in the exit interview:

“My involvement with gas flaring issues is driven by reducing the impact of the flaring around the host community and their benefits. The kind of issue that stood out for me is the impact of gas flaring on the host community that destroys the economy and reduces the impact of the flaring around the host community and their benefits”.

Though there is support for economic compensation and other distributive benefits, there is less support for strong procedural justice mechanisms at the local scale. For example, there was little support for providing communities with effective veto powers of the oil and gas development S23, nor for providing community decision-making

¹ Distinguishing statements (highlighted with * in the descriptions).

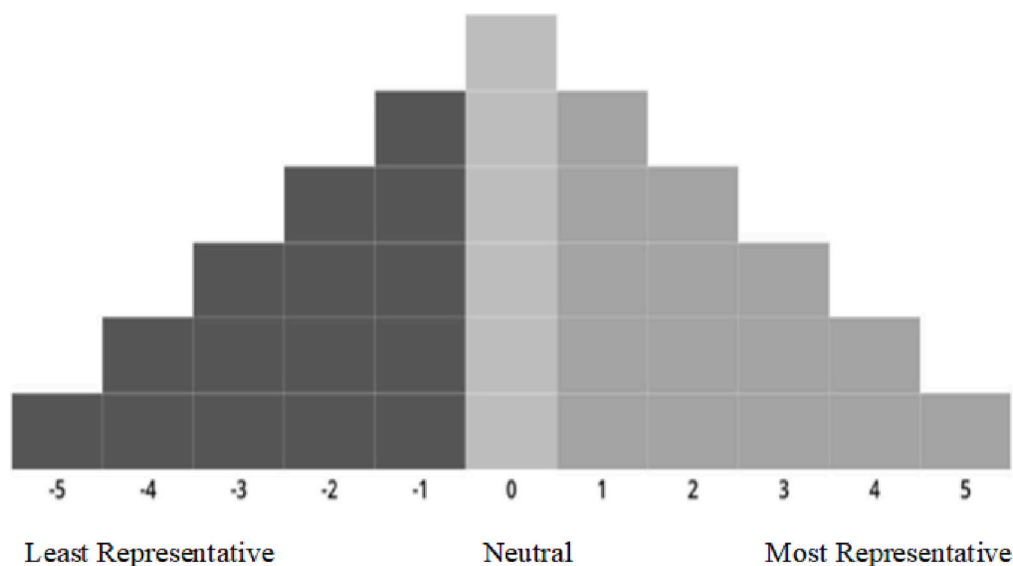


Fig. 1. Quasi-normal distribution of the final sort.

control powers through EIA S24*, or watchdog powers to oversee government-led implementation of gas flaring governance mechanisms S21*. There is, in essence, a rejection of place-based politicisation of gas flaring impacts on the local host communities. Hence, there was no support for government intervention in protecting communities from disruption to place attachment and place identity resulting from environmental harm (such that local host communities feel dispossessed of their land and livelihoods) S28*. This perspective can therefore be characterised as supporting economic redistributive and ‘top-down’ regulatory redress to prevent environmental injustices from flaring, though without community-level procedural/participatory decision-making control.

4.3. Business responsibility and social license to operate (perspective C)

Perspective C is characterised by industry and government-led solutions to energy justice in the oil and gas sector, emphasising the issue of trust S19 - often termed a *social license to operate* - through building business credibility and community relationships during routine oil and gas operations. The desire for proponents of perspective C for a full EIA for any activities where gas flaring would occur S24 reveals a need for regulatory and participatory input to governing gas flaring operations, given a lack of trust in industry activities. As respondent 20 indicated in the exit interview:

“The main issues that stood out are the environmental challenges faced by the local communities. For example, the Niger Delta region in Nigeria is experiencing significant environmental pollution, and the Federal or State Government is not doing enough to tackle the issues. In addition, the oil companies are not considering the impacts of their actions on people and the community”.

Within this perspective, gas flaring is defined primarily as an issue of good governance rather than gas flaring elimination. The perspective specifically formulates flaring as an issue of industry transparency as per S1, and the role of data availability on gas flaring and flaring impacts to public audiences in S17, alongside broader action to reduce corruption and rent-seeking among government authorities and industries in S12*. As respondent 28 stated:

“Oil and gas is the mainstream of funds in Alberta. Albertans want exploration but not in their backyard. I have been involved in many hearings where flaring was the main concern. Some concerns were due to being uninformed, and others led to good changes”.

Therefore, transparency, clear communication, and accountability are key aspects of this discursive framing of flaring.

Other concerns in perspective C relate to the role of state and private finance in governing and regulating the oil and gas industry. There is strong support for the Polluter Pays Principle (S30) - that private finance from oil and gas revenue should support the environmental amelioration of flaring S18. Also, there is strong support for governments to lead decisions on oil and gas flaring in the broader national interest S25*. On the contrary, there is opposition to reducing flaring using state finances as shown in S18, and in providing economic redress to affected communities through financial compensation or benefits in kind S3*.

As an energy justice issue, proponents of perspective C present natural gas as providing environmental benefits as a lower carbon fossil fuel than, for example, coal (S8*), with gas seen as a so-called bridge fuel. However, environmental justice must involve regulatory and planning measures that ensure environmental protection at local scales - primarily through support for processes of EIA S24*, rather than local authority S11, or local community decision-making control S23.

To summarise, proponents of perspective C tend to favour market-based and business-led solutions to oil and gas flaring, primarily focusing on the governance arrangements for businesses to ensure accountability, transparency and community-relationship building to ensure good practice within the industry.

4.4. Localism and community empowerment (perspective D)

Perspective D is characterised by the role of community control in environmental decision-making and the procedural dimensions of justice in gas flaring governance. Of particular interest is the role of community power in deciding on gas developments within the areas in which they live S23. As respondent 14 stated in the exit interview:

“Communities should have more power regarding decision-making, and companies and governments should be more transparent to ensure that communities are informed to make decisions. Activities that adversely affect the environment should be limited through legislation, taxation etc., regardless of the perceived economic benefit of these activities”.

Community empowerment also has economic redistribution dimensions, as proponents argue that the revenue from gas production insufficiently compensates for the environmental costs associated with flaring. There is a concern that the costs and benefits of oil and gas production are unevenly distributed and must be re-balanced S7*, to

ensure fairness to local communities S5*. Redistributive mechanisms, such as subsidised electricity (or other forms of benefit in kind), are favoured as a compensation mechanism for hosting gas flaring operations as shown in S3*. In one exit interview, respondent 7 noted:

“The main issues that stood out were balancing the environmental and health cost of flaring and the financial benefits to host communities”.

Perspective D is therefore defined through localism and community empowerment mechanisms to ensure environmental justice for gas-flaring-affected communities through EIA S24*, and economic redistribution mechanisms to ensure fair distributive justice to those negatively impacted by adverse health and environmental effects.

5. Discussion

The four dominant perspectives collectively account for 58 % of the variation in perspectives on global gas flaring and energy justice issues. Each represents different aggregate views on gas flaring and energy justice, revealing potential agreement and disagreement held within and between stakeholder groups. Understanding these dynamics is useful to inform future stakeholder engagement and further empirical ethics study of energy justice and gas flaring governance. It reveals likely areas for consensus building (“quick wins” where conflict is less likely to occur) and likely areas of disagreement that would require careful facilitation of dialogue among competing perspectives. These are discussed in the following section.

5.1. Areas of agreement

The correlation between factors reveals “consensus statements”, where the various perspectives indicate tentative agreement. For instance, where factors 1 and 2 agree, but factors 3 and 4 disagree, there are benefits in exploring the source of the belief systems around that issue [67]. We use the terms “agreement/consensus” and “disagreement/dissensus” in our assessment of the variance across factor z-scores for each statement. Eleven ($n = 11$) out of the 36 statements were identified as ‘consensus statements’ based on z-scores. However, five key areas of consensus were on S11, S20, S27, S30, and S16, relating to all perspectives cutting across the four identified tenets of justice.

All four perspectives agree that local authorities should not be the managing authorities for gas flaring reduction in S11 (procedural justice). Yet, they agree that gas flaring management must incorporate regulatory and planning measures that guarantee environmental protection at local levels while integrating host community concerns into national oil and gas decision-making as per S20 (procedural/recognition justice). More specifically, agreed normative perspectives on procedural justice emphasise work to improve institutional processes that create inequities [29,68] and ensure due process, representative public participation, and process-oriented and deliberative democratic solutions to environmental governance of gas flaring [69–71]. Recognition justice is essential to ensuring just procedural outcomes for marginalised communities [72] on S20 across all perspectives is illustrative of a desire to link local, national, and global scales of energy justice – ‘scaling up’ local community concerns to national and supra-national policy authorities [73].

Notable is a rejection of utilitarian ‘sacrifice zone’ governance solutions [74]. All perspectives agreed that population density should not be a factor in the acceptability of flaring, notwithstanding geographical location S27. This is representative of broad acceptance of an egalitarian, rights-based normative position that all people have a right to a clean and safe environment [75–79].

Distributive justice concerns that the costs and benefits of oil and gas production needed to be re-balanced S7* were expressed by consensus on the Polluter Pays Principle as a starting point for distributive justice S30. This mirrors empirical findings of uneven benefit/risk distribution

in research into gas flaring practices [33,80–83]. Distributive justice is also defined in relation to the challenge of global *extractivism* and *enclaving* [84–86] defined in S16. Perspective A was neutral, and perspectives B, C and D disagreed that gas resources were solely extracted to benefit another country’s economy S16. Concerns over distributive injustice and vulnerability, especially through job losses in local host communities where oil and gas enclave development is prevalent, were highlighted in the exit interviews. It is noteworthy that concession agreements still give IOCs the right to operate within an oil and gas enclave, a social and economic consequence of global fossil fuel supply chains [85]. Gas flaring within enclave economies alters the structure of host communities’ job opportunities – IOCs often export labour in the form of expatriates to the enclave regions, exacerbating rent-seeking and corruption, e.g., S12, and altering the regulatory structure in countries with a unitary system or low regulatory compliance [84,87]. The relationship between host community benefits through job creation and the extractive nature of capital resource flows through enclaves of migrant labour illustrated a broader distributive global justice concern within oil and gas supply chains, and this is a key concern for the stakeholders in this study.

Six other statements that do not distinguish between factors are crucial as they form a common basis for building a future gas flaring governance approach [88] (Table 5).

The consensus around distributive, procedural, and recognition normative positions, support/non-support for zero-flaring in S6, S13 and S17, and utterances from the exit interviews indicate a growing awareness of gas flaring’s negative impact on the natural environment and a desire to accelerate low-carbon energy transitions as a result. However, disagreement and neutrality across all perspectives relating to government subsidisation of oil and gas production S6 show equivocation over the role of government in sponsoring gas as a bridge fuel (or as means to ameliorate energy security of supply) [89–91]. This equivocation is likely reflective of the diversity of stakeholders in the P-set, including strong oil and gas industry representation.

Although voluntary disclosure of gas flaring emissions by IOCs is desirable, S13, the quality of such GHG emissions reporting remains controversial. Empirical analysis of voluntary disclosure reveals that shareholders often react reflexively by superficially enhancing disclosure only under conditions of public controversy and enhanced public scrutiny [92–96]. Near-universal agreement about S13 suggests that disclosure of gas flaring emissions by IOCs is crucial. Ensuring mandatory environmental reporting whereby all data on gas flaring emissions, health impacts and distribution patterns are publicly available, e.g., S17, may also potentially benefit market valuation [97]. Accordingly, agreement across all perspectives regarding S13 and S17 indicates a desire for greater transparency of information provided to the public as a matter of procedural justice.

Moreover, rent-seeking linked to the oft-discussed “resource curse” has been and still is a major concern for oil and gas-producing countries. A persistent lack of transparency, industry accountability, and

Table 5
Q-sort statements that do not distinguish between factors extracted from Table 3.

Statement	Statement no.
Governments should subsidise oil and gas production.	S6
Voluntary disclosure of gas flaring emissions by oil and gas companies is desirable.	S13
All data on gas flaring emissions, health impacts, and distribution patterns should be made publicly available.	S17
To tackle gas flaring, we should improve transparency and industry accountability in the global oil and gas sector.	S1
Oil and gas companies should build long-term community trust in the locations where they extract natural resources.	S19
A thriving oil and gas sector is essential for the economic vitality of rural gas-flaring host communities.	S10

Table 6

Q-sort statements and numbers of critical areas of clear discursive conflict across all four perspectives extracted from Table 3.

Statement	Statement no.
We should reduce the amount of waste gas in order to improve profitability in extraction.	S2
The dangers of gas flaring are exaggerated.	S15
Current environmental protections from oil and gas flaring sufficiently balance ecological costs and economic benefits.	S7
Action taken on rent-seeking and corruption should be the first step in tackling gas flaring.	S12
Governments should set up an independent community watchdog group and an advisory group of community leaders to examine, monitor and review government regulatory agencies and the activities of international oil companies.	S21
Oil and gas companies should be mandated to complete a full EIA for any activities where gas flaring will occur.	S24
Global gas flaring produces avoidable emissions, and legislation should stop such practices.	S35
Governments need to protect communities from feeling dispossessed of their land and livelihoods.	S28

substantial revenue accumulation by influential groups or individuals [98] raises questions concerning political will to curb gas flaring. However, perspectives show some disagreement that rent-seeking (implying non-support) across perspectives A, B and D, and slight agreement by C on rent-seeking/corruption and lack of transparency (components of the resource curse) contradicts some existing studies, e. g., [80,99–102]. Neutrality on perspective A and overwhelming ranking by perspectives C and D for S1 are further indicative of an existential lack of transparency and accountability in the global oil and gas sector. However, there is a global standard to enhance transparency and accountability in the form of the Extractive Industries Transparency Initiative (EITI) [103].

There was agreement that oil and gas were no longer essential to community social development S10. Moreover, the unequal distribution of benefits and burdens of oil and gas extraction actively damage social development – as energy injustice is associated with violent conflict, environmental degradation, displaced communities, and diminished democratic governance globally [104], particularly in unitary states with low levels of regulatory compliance [84,87,105] If the risks of gas flaring are construed as being exaggerated by domestic policy authorities S15, this may lead to recognition injustice as host communities become deliberately excluded from governance mechanisms, resulting in economic losses, environmental burdens, and social deprivation.

5.2. Areas of disagreement

From the z-scores analysis, $n = 17$ statements constituted points of disagreement identified as *distinguishing statements* (highlighted * in the descriptions).² Notably, eight statements represented areas of disagreement which indicate embedded conflicts over support/non-support for gas flaring and the four tenets of justice, reflecting critical areas of clear discursive conflict across all four perspectives (Table 6):

There are several important distinctions between the four perspectives relating to support or non-support for continued gas flaring operations, highlighted by statements S2, S15, and S7. There is a noticeable disagreement between perspective A relative to B, C and D on S2 with Q-sort values $(-1 +3 +2 +1)$ ³; perspective B relative to A, C and D on S15 with Q-sort values $(-5 +1 -2 -4)$; and perspective B relative to A, C and D on S7 with Q-sort values $(-3 +1 -1 -4)$. On the issues around reducing the amount of waste gas to improve profitability in extraction

² Statements constituted points of disagreement identified as distinguishing statements (highlighted with * in the descriptions).

³ Numbers in the brackets are Q-sort values extracted from Table 3.

S2, perspectives B, C, and D agree, while A slightly disagrees. Since S15 presents the dangers of gas flaring as being exaggerated, it also maintains similarities in ranking with the view that the current environmental protections from oil and gas flaring sufficiently balance the ecological costs and economic benefits S7. These disagreements across the perspectives provide context to their relevant support or non-support for gas flaring operations. Of note is the relative utilitarianism presented in defining support/non-support positions, specifically with regard to a desire to *balance* flaring economic benefits at the national scale against environmental and social development burdens at the host community scale. As stated by respondent 3:

“My choices are based on balancing the benefits and trade-offs of gas flaring when comparing its socio-economic benefit with the long-term environmental impact on the environment. The statements about who should be responsible for legislation and how much self-regulation is acceptable stood out because it is quite obvious that profit-driven establishments are not very good at looking at anything else”.

Furthermore, respondent 2 stated:

“The oil and gas business is necessary for the economic growth of the world. It can, however, be done more responsibly. The industrialised western world is driving the climate agenda while the developing countries in Africa and Asia need the oil and gas to grow and become fully industrialised”.

Further discursive disagreement arises across statements S12, S21, S24, and S35. Regarding S12 with Q-sort values $(-2 -3 +1 -1)$, perspectives A, B, and D disagree with the claim that acting on rent-seeking and corruption is the first step in tackling gas flaring. While perspectives A, B, and D’s disagreement on S12 tend to prioritise economic benefit over gas flaring reduction, perspective C slightly agrees that rent-seeking and corruption are the key issues to address. Furthermore, there is a conflict concerning S21 with Q-sort values $(+1 -3 +1 +2)$. It emphasises that governments should set up independent community watchdog groups and advisory forums of community leaders to examine, monitor and review government regulatory agencies and the activities of international oil companies.

There is a clear distinction between perspectives B versus A, C and D on this issue of community-led independent governance arrangements. Advocates of perspectives A, C and D support this initiative, while perspective B advocates for the status quo. On S24 with Q-sort values $(+2 -3 +3 +4)$, perspectives A, C and D largely support mandating oil and gas companies to complete a full EIA for any activities where gas flaring will occur, but B again disagrees. On S35 $(+4 +5 +1 -3)$, regarding employing legislation to stop global gas flaring, which constitutes avoidable emissions, perspectives A, B, and C overwhelmingly support this assertion, but D disagrees. Similarly, on S28 $(+3 -2 +2 +2)$, disagreement emerged between perspective B relative to A, C and D on the issue of the government’s responsibility in protecting communities from becoming dispossessed of their land and livelihoods. Again, while perspectives A, C and D support this perspective, B disagrees. For S26 $(+2 +3 0 -1)$, perspectives A and B show support for a national regulatory agency making decisions on managing gas flaring environmental impacts (procedural justice). However, D opposes, and C remains neutral. Across these perspectives, we see a range of responses to the mechanisms of governance desired to ensure transparency, social accountability, the tackling of corruption, and ensuring community cohesion, and regulatory compliance, which underlie overall agreement on the aim to achieve ‘good governance’ within the oil and gas sector and the authorities that set the regulatory agenda. Further engagement and policy analysis should therefore focus on finding locally-context-sensitive governance mechanisms that achieve this goal.

Disagreement emerges on S3, S26, S29, and S31. S3 $(-1 +3 -4 +4)$ concerns compensation and electricity subsidies for communities affected by gas flaring (an issue of distributive justice), in which

Table 7
Policy proposals emerging from Q-methodology analysis of stakeholders' perspectives on global gas flaring and energy justice.

Concept	Statement example	Policy proposal
Distributive justice	Communities affected by gas flaring should be compensated with subsidised electricity, S3. The benefits and burdens of gas flaring should be shared fairly between rich and poor communities, S5. Action taken on rent-seeking and corruption should be the first step in tackling gas flaring, S12.	Extend electricity subsidies to gas-flaring host communities. Require IOCs to increase the use of local materials and labour or share more benefits with host communities. Improve transparency, including involving the public in gas flaring projects and providing information on how locally affected people can meaningfully participate in decision-making. Both the governments of gas flaring nations and IOCs should increase the use of local materials, supply chains, and labour.
Procedural justice	Gas flaring is a problem when the industry is dominated by international capital, and oil and gas companies extract the value of the gas to another country, S16. Oil and gas companies should voluntarily adopt the polluter pays principles offering compensation and funding for environmental remediation, S30. To tackle gas flaring, we should improve transparency and industry accountability in the global oil and gas sector, S1. The environmental impacts of oil and gas flaring are experienced locally and should therefore be managed by local authorities, S11. Host communities' concerns about gas flaring impacts should be integrated into governments' oil and gas exploration and development decisions, S20. Governments should set up an independent community watchdog group and an advisory group of community leaders to examine, monitor and review government regulatory agencies and the activities of international oil companies, S21. Oil and gas companies should be mandated to complete a full Environmental Impact Assessment for any activities where gas flaring will occur, S24.	The governments and IOCs are to compensate host communities consistently and proactively to avert civil conflict and unrest. Improve transparency by implementing the Extractive Industries Transparency Initiative (EITI). Equitably include host communities in gas flaring policies and decision-making. Integrating host communities' concerns about gas flaring into governments' oil and gas exploration and development decisions. Relevant public authorities should set up independent watchdog groups to examine, monitor and review government regulatory agencies.
Recognition justice	Oil and gas companies should build long-term community trust in the locations where they extract natural resources, S19.	Mandate IOCs to complete a full Environmental Impact Assessment (EIA). Enable genuine integration with the various gas flaring host communities. Host communities should be fairly and adequately represented in gas flaring processes. Avoid the use of physical threats by the states and support dialogue with host communities.
Cosmopolitan justice	Governments need to protect communities from feeling dispossessed of their land and livelihoods, S28. It is acceptable for gas flaring to take place in areas of low population density, S27. Heavy gas flaring nations should compensate neighbouring countries for environmental impacts caused by transboundary pollution, S29. Governments should accept responsibility for gas flaring impacts, even if privately owned industries cause them, S31.	Engage with indigenous peoples as fully recognised and respected stakeholders in the gas flaring initiatives occurring within local host communities. Gas flaring often takes place in <i>sacrifice zones</i> – places populated by economically and politically vulnerable communities, in which collective benefits to the economy as a whole (i.e., the extraction of energy resources for global commodity sale) are produced at the expense of the local environment and the community it supports. Carefully manage gas flaring pollution in sacrifice zones. Give host communities control of their land. Governments and IOCs should provide clean and accessible water services for host communities within the sacrifice zones. Facilitate international mechanisms/domestic policies to tackle transboundary pollution and other global externalities. Governments should reconsider and facilitate the restoration of degraded host communities through preventive and forward-thinking actions.

perspectives B and D agree, while A and C disagree. This also links S5 concerning sharing benefits and burdens of natural gas, which C disagrees with. It is interesting to note that perspective C takes a non-egalitarian position, revealing that a redistributive approach is not universally favoured among stakeholder groups despite evidence that this improves social development outcomes and the favourability of oil and gas extraction within host communities [5,7,8,79,106]. There is evidence of modest agreement on S29 (+1 -1 +1 0) that heavy gas flaring nations should directly compensate neighbouring countries for environmental impacts caused by transboundary pollution (an issue of cosmopolitan justice). Though perspectives A and C show modest support, B disagrees, and D is neutral. The final distinguishing point (S31; +3 -2 -1 +1) relates specifically to restorative/cosmopolitan justice, positioning governments to accept responsibility for gas flaring impacts even if privately owned industries cause them. This was a polarising issue. Perspectives A and D support this statement, while B and C again disagree. S31 emphasises guaranteed rights for protection from the impacts of flaring irrespective of who caused them, an issue Hazrati and

Hefron [107] discussed as a form of *restorative justice* through which ameliorative compensation mechanisms are offered in the face of environmental risk. Restorative justice is, therefore, worthy of further exploration through heterogeneous stakeholder dialogue to capture the nature and breadth of this polarisation.

6. Conclusions and implications for future research

Although gas flaring justice is recognised as a critical environmental governance challenge internationally, there is relatively little assessment of the justice dimensions from the 'bottom-up' from diverse networks of stakeholders involved in industry activity, compliance, regulation, and community engagement. A global justice-focused approach to gas flaring gives an expanded conceptual perspective on the injustices suffered and possible solutions, as demonstrated by this study. Q-method is a valuable tool in studying such issues of *empirical ethics* – an approach whereby social science data is used to clarify and contextualise normative moral positions on, in this case, the energy

justice dimensions of global gas flaring. Q-method offers insight into diverse stakeholder positions on controversial issues, uncovering the shared logic behind such positions. Our Q-method analysis identified four normative perspectives: a) government-led zero flaring policy, b) multi-scalar economic governance, c) business responsibility and social license to operate, and d) localism and community empowerment. The largest number of Q-sorters loading on perspective A shows a common aspiration for zero gas flaring globally, a desire for greater outreach and awareness-raising of the core social and environmental impacts of flaring, and legislative practices to actively halt emissions. These features collectively represent fundamental conflicts around global gas flaring perception, structured and negotiated by different stakeholders.

When examining the interplay of the four tenets of energy justice embedded in the Q-statements, we find that: firstly, there is broad overall stakeholder support for zero routine flaring (ZRF) globally across the perspectives. This indicates support for existing policies (ZRF by 2030 and zero emissions by 2050 captured in post-Paris climate policy). Though our sample is not demographically representative, the diversity of stakeholder positions and backgrounds indicates the *discursive dominance* of zero flaring in future oil and gas governance. Second, we find support for coordinated multi-scalar governance in response to the energy injustices identified. Linking international-national-local regulatory authorities is desired to protect marginalised communities. Third, egalitarian rights-based approaches are generally prioritised over utilitarian approaches, e.g., risk-benefit calculations to define the acceptability of policy approaches or consideration of population density in planning for oil and gas extraction. Fourth, business responsibility necessitates emphasis upon corporate transparency and accountability – specifically transparent communication of flaring activities and impacts and commitment to the Polluter Pays Principle of environmental redress/restorative justice to ameliorate the impacts to affected host communities. Finally, we find that stakeholder disagreement principally centres upon the practical mechanisms to achieve egalitarian just outcomes rather than the core principles of justice underlying a zero-flaring policy approach. These mechanisms vary substantially: covering mechanisms of community compensation (e.g., subsidised electricity and transboundary governance of compensation), the role of local authorities in governance and regulatory compliance, regulatory design (including Environmental Impact Assessment), and the right mechanisms to tackle rent-seeking and corruption. We conclude, therefore, that further negotiation on the implementation of gas flaring elimination, rather than the goal itself, is needed through careful stakeholder dialogue and negotiation.

Finally, the four specific tenets of energy justice we examined are not the only justice issues associated with flaring. However, our findings underpin the overarching rationale for a net zero routine flaring target, a goal supported across a range of policy, NGOs, and industry stakeholder perspectives. Where zero-flaring is impossible, it is morally necessary for policy and industry actors to not only minimise social and environmental burdens to vulnerable communities, but also to make such burdens socio-culturally 'visible' and distributed equitably based on representative and participatory decision-making processes backed by adequate regulatory mechanisms such as EIA. If natural gas plays is to play a crucial role in the transition and global climate change mitigation

strategies across the world, it will also require stakeholder buy-in to proceed in a just, sustainable, and more equitable way. We suggest therefore a series of policy proposals to prevent or minimise injustice associated with gas flaring based upon the findings of the Q-method analysis, shown in [Table 7](#).

6.1. Note on the use of Q-methodology and future research

Q-methodology has distinct advantages for empirical ethics research into energy justice as it requires a small sample size to generate statistically significant results with participant-driven characterisation of normative positions. Q-methodology can reduce researcher bias associated with predefined questions on quantitative surveys or highly structured interview protocols. However, there are some limitations to this research. Firstly, the top-two gas flaring nations (Russia and Iraq) were not represented in the P-set despite efforts to secure such contacts. Secondly, Q-methodology requires short, accessible statements to facilitate analysis [66], losing some of the richness of qualitative data. However, the exit interviews enabled us to bring this qualitative richness back to contextual the meaning of the aggregate perspectives produced through Q-analysis. Thirdly, the four factors had an explained variance of 58 % (the threshold is 50 %), leaving 42 % of the total data unexplained. Finally, Q methodology is based on purposive/snowball sampling techniques of a small-*n* P-set. We used purposive/snowball sampling. As such, participants were allowed to enter the survey with or without a code to encourage participation due to the nature of the survey. In one instance, participants re-forwarded the survey link to people they believed were familiar with the topic. Two participants entered the survey without a code to remain anonymous.

We note that as is common to Q-method studies, data is representative of the broader *discourse* concerning the topic rather than to a specific demographic, so the findings cannot be generalised to a larger population. Further quantitative survey evaluation of these perspectives tested among a demographically representative population would provide generalisable findings at the population level.

CRediT authorship contribution statement

Godwin O. Aigbe: Conceptualization, Methodology, Writing- Original draft preparation, Investigation, Formal analysis.

Matthew Cotton: Methodology, Validation, Writing-Reviewing and Editing.

Lindsay C. Stringer: Validation, Writing-Reviewing and Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

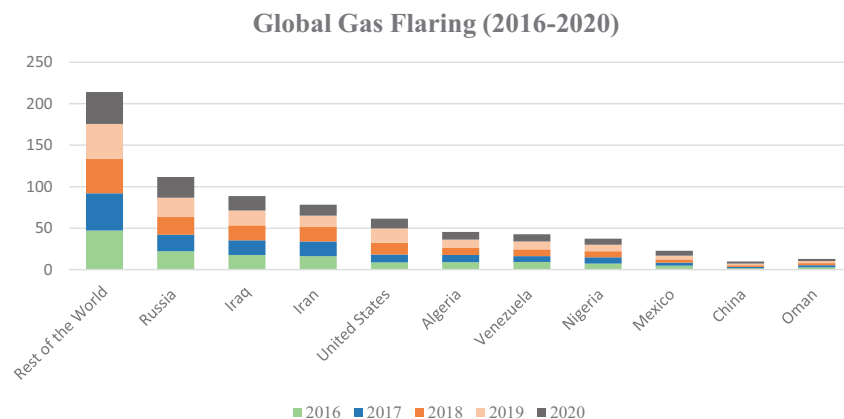
Data availability

No data was used for the research described in the article.

Appendix A. Appendices

Table A1

Top ten countries with high gas flaring and the rest of the world in Billion Cubic Metres (bcm) from 2016 to 2020.



Global gas flaring-Top ten countries with high gas flaring and the rest of the world in Billion Cubic Metres (bcm) from 2016 to 2020. Data source: The World Bank/ GGFR (2021).

Table A2

Initial Q-statements from preliminary interviews, consultations and experts survey, and qualitative interview data.

No. Statement

1. Rent-seeking corruption, the entrenchment of corruption exacerbates gas flaring
2. Gas flaring promotes inequality and wealth accumulation by the elites
3. IOC's authoritarian business models particularly in poor countries have exacerbated gas flaring over the years
4. Vulnerable host communities are excluded from accessing high energy prices (electricity)
5. Energy poverty is common in gas flaring host communities, particularly in developing countries.
6. Benefits and burdens of gas flaring are not evenly distributed, and we are becoming too dependent on natural gas.
7. Host communities bear a disproportionate share of the negative environmental consequences resulting from gas flaring and government policies.
8. Maldistribution of environmental and social impacts of gas flaring fuels restiveness and conflicts, especially in developing countries.
9. Gas flaring and social deprivation cause crime.
10. Gas flaring policies have stripped host communities of the right to clean water, food, air, and a safe environment.
11. Gas flaring host communities do not enjoy the same clean air as non-oil and gas-producing communities.
12. Loss of jobs to expatriates/disruption to traditional businesses
13. Government's fiscal incentives for investment in the economic utilisation of flared gas promote flaring.
14. The decision-makers seek out and facilitate the involvement of those host communities potentially affected by gas flaring.
15. Host communities' concerns are considered in gas flaring decision-making processes.
16. Governments should use public input in making decisions about gas flaring.
17. Governments should set up an advisory group of community leaders to review what the agencies are doing.
18. There should be an independent community watchdog group to examine and monitor government regulatory agencies' and IOCs' activities.
19. State and local government agencies and officials should be involved in gas flaring decisions.
20. Regulatory bodies' staff should be sufficiently knowledgeable about the technical issues.
21. Energy price increases further marginalise deprived gas flaring host communities and exacerbate vulnerability
22. Maldistribution and not recognising gas flaring host communities in decisions about flaring fuels restiveness and conflicts, especially in developing countries.
23. Exclusion of those living in the host communities from decisions concerning gas flaring is necessary for the governments and IOCs.
24. Enclave structure exacerbates gas flaring, injustice, socio-economic marginalisation, and dispossession in the host communities.
25. Host communities should have an opportunity to participate in decisions about gas flaring
26. The public's contribution has influenced the regulatory agency's decision on gas flaring.
27. The impacts of gas flaring and climate change would fall disproportionately on already vulnerable gas flaring populations.
28. Gas flaring contributes to extreme forms of socio-economic marginalisation.
29. Governments of gas flaring nations deliberately suppress gas flaring data and scientific data for political gain
30. Oil and gas giants back anti-gas flaring lobby groups despite pledges while fuelling climate change.
31. Countries without oil and gas have stringent environmental laws sufficiently stringent
32. Gas flaring nations need to compensate others for climate change impacts due to transboundary pollution.
33. Gas flaring is a source of major environmental problems and needs significant modification.
34. Oil and gas companies that cause environmental damage should be more heavily punished.
35. Governments and IOCs should feel guilty if they cause pollution incidents, whatever the cause.
36. Environmental and health harm to gas flaring is a source of shame for those who cause it.
37. IOCs should always protect the local host communities regardless of what incentive is available from their host country.
38. The more money you make from gas flaring, the more you should be willing to spend on enhancing welfare and the environment and other environmental concerns.

(continued on next page)

Table A2 (continued)

39. Information concerning gas flaring the IOCs and oil and gas producing countries are reporting should be unbiased and accurate.
40. Gas flaring is the world's biggest emission problem and capping gas flaring is the key to solving climate change.
41. Flaring should be banned worldwide and countries that flare gas should be banned.
42. The conditions in and around gas flaring host communities must conserve livelihood and lifestyles.
43. Global gas flaring is preventable emissions and practice can be stopped through legislation.
44. Gas flaring emits black carbon, methane, and volatile organic compounds and contributes to climate change
45. Enough is being done to protect and enhance the host communities' environment currently.
46. Gas flaring reduction is in a better state now than it has ever been.
47. Oil and Gas Companies and gas flaring countries have a greater responsibility to produce energy through fossil fuel development than to preserve the rural environment.
48. A successful oil and gas sector is important for the vitality of rural gas flaring host communities.
49. Many of the justice issues and health impacts caused by gas flaring that environmental campaigners/NGOs want to protect are not worth worrying about.
50. Gas flaring should be continued because revenue generation is more important than gas flaring.
51. Gas flaring and pollution of host communities are acceptable in some extreme cases
52. Corruption in the oil and gas industry can be acceptable in some cases.
53. Voluntary disclosure is acceptable in greenhouse gas emissions reduction and flaring voluntary environmental programs should reduce emissions
54. The dangers of gas flaring are exaggerated, gas flaring does not interfere with human activities, and gas flaring is not a crime and does not exist
55. Greenhouse gas emissions through routine flaring are widespread among energy companies as part of crude oil production.

Table A3

Develop the concourse.

We sampled the concourse using four theoretically driven criteria:

1. Specific preference was given to articles that include gas flaring, energy and environmental justice, low carbon energy system and transition concept.
2. Articles with a comprehensive overview of gas flaring in energy/environmental justice, production and systems, consumption, activism, energy security, and climate change.
3. Articles that include and underscore all the concepts.
4. No emphasis and preference for date of publications.

The results were sorted based on the four criteria without considering the publication date and resulted in a total of 393 articles. Following Steelman and Maguire's (1999) approach, an unstructured sampling approach was utilised for statement sampling to develop the Q-set.

The corpus was limited to English language publications. Literature considered included extracts from articles on gas flaring and environmental justice, websites and social/professional network message boards, online newspaper articles, press releases from gas exploration companies, government statements on gas flaring, grassroots activists/ environmental campaigners, and NGO publications.

Table A4

Unrotated factor matrix.

Participant	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
15YT	0.51568	0.41172	0.31444	-0.23374	-0.158	-0.08512	-0.26861	-0.12176
1ZEHM58	0.18835	0.83689	-0.05738	-0.08554	-0.08825	-0.04795	0.19099	0.00455
2WDSJC	0.5876	-0.40212	-0.17751	-0.0757	0.02589	-0.03506	0.5242	0.15014
3HIBT	0.45939	0.05136	0.44434	-0.37581	-0.30621	-0.17732	0.03273	-0.15375
5P9NBFU5	0.6801	0.04935	-0.39223	0.10013	0.0551	-0.01916	0.0633	-0.09506
6I62	0.78031	-0.12103	-0.22688	0.23214	-0.06027	0.04069	-0.25152	-0.01676
72G38DG	0.86697	0.15546	-0.05893	0.08843	0.06881	-0.10924	-0.02491	0.06524
8DGFJ	0.55189	0.0926	0.26842	0.53567	-0.16547	-0.0806	0.13297	-0.2464
AR9L	0.38734	0.05742	0.23022	-0.31937	-0.13911	-0.23373	-0.33894	0.36936
AY2DBB6	0.74466	-0.15919	-0.01442	-0.23607	-0.16961	0.03944	0.19705	0.09061
B2MP	0.2523	0.01992	0.29649	-0.06653	0.5977	0.45032	0.21774	-0.02714
BQHJS8	0.85134	-0.098	-0.24333	0.17982	-0.04174	0.04053	-0.20411	-0.15764
C1BQUI	0.76152	0.16594	-0.35661	-0.0122	-0.0891	0.05432	-0.01037	0.0083
CT8EOR	0.4128	0.3176	0.2927	0.56717	0.16636	0.07284	0.01527	-0.00897
CWQQ	0.45634	0.38072	0.14801	0.51036	0.19065	0.0761	-0.15802	0.28435
D05E86	0.56996	-0.37066	-0.12139	0.09806	-0.18436	0.06429	-0.40394	0.17886
FD84	0.25228	0.43393	-0.45059	-0.39694	-0.04393	0.41718	0.0293	-0.16936
JGNMN45	0.71876	-0.11495	-0.04646	-0.09611	-0.27099	0.11716	0.04261	0.15149
L4MA87P	0.71784	0.30547	0.12961	0.04184	-0.19575	0.0899	-0.10741	-0.22872
L17GQN6	0.51669	-0.25518	0.03751	-0.14438	0.47006	0.26659	-0.01521	0.18129
M344Q1NE	0.09615	0.0411	0.20019	0.20657	-0.49149	0.64926	0.26167	-0.04719
M87O	0.28282	0.43807	0.22499	-0.30806	0.21027	0.12459	0.18972	0.39933
OKFO9NXA	0.50586	-0.21554	0.23993	0.09126	-0.32102	-0.10746	0.39444	-0.2706
OQ4HCTYW	0.48047	-0.26168	0.19172	0.16874	0.24349	0.41339	-0.27185	-0.07765
PAN5RJT4	0.7294	-0.28007	-0.026	-0.31536	0.24649	-0.13778	0.05194	-0.25453

(continued on next page)

Table A4 (continued)

Participant	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
QJ0A	0.81123	0.07324	-0.15702	0.04157	0.13397	-0.18424	-0.18355	-0.12989
QTAEH	0.68679	-0.52962	-0.10806	-0.21012	0.17327	-0.01461	0.00135	-0.17819
S6E3	0.27452	-0.06431	0.65089	-0.30041	0.14693	0.12553	-0.18762	-0.29685
UL38W	0.74292	-0.12568	-0.3097	0.16454	0.02418	-0.01642	0.18552	0.12602
VOIE	0.63363	0.31046	0.18056	-0.08134	0.28438	-0.28048	0.20622	0.04798
VUZN	0.69566	0.2071	-0.19857	0.16908	0.11536	-0.27112	0.15571	0.06408
VY90ID	0.90592	0.00525	0.22021	-0.06254	0.02026	0.0349	-0.02553	0.01514
WLNFAPO	0.49207	-0.24624	0.20597	-0.08105	-0.4709	0.23215	-0.01221	0.42638
X03A	0.07788	0.4446	-0.5461	-0.32579	-0.06286	0.30032	-0.15038	-0.14043
YJ307	0.84911	0.03035	0.09132	-0.12687	-0.02863	-0.18035	0.01537	0.09604

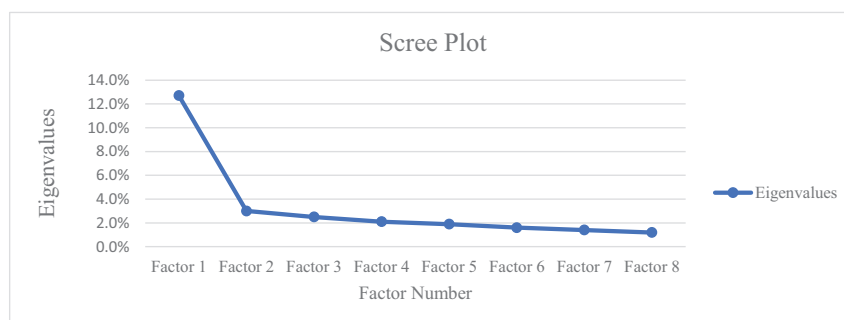


Fig. A1. Scree plot of factor Eigenvalues.

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