A Framework for assessing the contribution of UK local authorities towards compliance with the EU Ambient Air Quality Directive

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Abstract

Implementation outcomes of the Ambient Air Quality Directive (AAQD) (2008/50/EC)) are weak across European Union (EU) member states. In the UK, Local Authorities (LAs) must work towards reducing air pollution, however, means of assessing the extent and effectiveness of their contribution are limited. This paper develops a framework to evaluate policies implemented by UK LAs to address air pollution and applies it to Air Quality Action Plans (AQAP) of five cities. It looks at how and the extent to which LA air quality policies align with AAQD requirements, thus advancing empirical and academic knowledge on implementation literature surrounding multi-level governance, specifically the policy disconnect between the AAQD and UK Local Air Quality Management (LAQM). The application of the framework shows how LAs can better integrate AQAPs into their LAQM plans to assess, develop, improve and implement their air quality policies on the ground.

Keywords: EU Ambient Air Quality Directive (2008/50/EC); Policy disconnect; Action plans; Local Authorities; Assessment framework

Introduction

Exceedances of nitrogen dioxide (NO_2) legal limits, primarily from transport pollution, persist across 12 EU member states, including the UK (EEA, 2017; Nagl, Schneider & Thielen, 2016).

The implementation of air quality policies is complicated by the multi-level nature of the problem that they aim to tackle. Environmental issues such as air pollution require the cooperation of multiple institutional levels vis-à-vis national legislative and governance structures (Mickwitz, 2003; Gollata & Newig, 2017; Knill & Lenschow, 1998). In this regard, Bondarouk & Mastenbroek (2017) have highlighted the need to better assess the contribution made at local authority (LA) level to achieving EU environmental objectives, and proposed a framework which was subsequently adapted to evaluate the AAQD implementation performance of Dutch municipalities (Bondarouk & Liefferink, 2017). The authors identify three key dimensions for the evaluation: substance; scope; and effort. Their analysis highlights that implementation performance was dependent upon how serious municipalities were about tackling air quality (which in some cases led to over compliance) while also dealing with the challenges presented by the lack of measurable obligations from the AAQD. This paper builds on these contributions to assessing the LA's role in reducing ambient air pollution, with a focus on the UK. The UK requires new assessment tools specifically tailored to the UK air quality governance structure and legislative approach, and which are directly actionable by officers and practitioners.

In the Netherlands, "municipalities are obliged to implement all measures listed under the National Air Quality Cooperation Programme (NAQCP) otherwise they would have to pay back funding granted by the national authority" (Bondarouk & Liefferink, 2017, p. 738). This implies that AQAPs in the Netherlands are automatically implemented locally. This is not the case in the UK, in part due to the limited responsibility that local authorities have to achieve limit values or objectives (Chatterton, *et al.,* 2007; Barnes, *et al.,* 2018). Moreover, the UK currently implements two separate sets of regulations in a 'twin-track approach' to air quality management (Barnes, *et al.,* 2018); the national UK air quality legislation which is derived from the Environment Act (1995) (Air Quality Strategy (AQS)), and the AAQD (the National Emissions Ceilings (NEC) Directive (2016/2284/EU)). These have different governance approaches and legal requirements. For example, the EU AAQD requires member states to work at the scale of zones and agglomerations, while the national legislation works at the local authority scale (Defra, 2018c). This makes determining responsibilities for emissions, particularly those which cross LA boundaries challenging, and further complicates reporting to different authorities according to their respective requirements at each level (Barnes*, et al.,* 2018). Attempts to integrate the AAQD into national legislation have failed, and there therefore remains a significant policy disconnect between the two regimes (Barnes *et al.,* 2018).

This paper tackles the following research question: to what extent are LAs contributing towards the achievement of the AAQD? By building on Bondarouk and Liefferink's framework and integrating multidisciplinary insights, the paper develops a supporting tool for decision-makers to use to evaluate UK air quality policies at the local level in a way that considers, and crucially, contributes to, closing the policy disconnect. The empirical application of our framework to the UK allows us to test it in a multi-level governance setting that presents a clearly identifiable and tractable policy disconnect between two different government levels. The contribution of this paper is multidisciplinary as it brings together insights from EU public policy, air quality management, public health, and transport management, which are critical for the success of air quality policies. Tackling the case of the policy disconnect in the UK air quality domain allows us to address key theoretical issues in the multi-level governance literature, namely coordination failures, mismatches between administrative areas, gaps and asymmetries of information (Allain-Dupré, 2020; Charbit, 2020). Furthermore, building our framework on insights from the EU multi-level governance literature enables it to be adapted to analyse air quality policies in other EU multi-level governance systems and policies. Finally, by directly addressing these key challenges, our framework represents a supporting tool for the development of policies that are better aligned and coordinated, thus reducing policy implementation cost, duplication and enabling the delivery of stronger environmental outcomes.

The next section outlines the challenges of implementing EU law and UK air quality policies; it describes the development of a UK-specific assessment framework, and applies it to five UK cities (Bristol, Glasgow, Leeds, Manchester and Newcastle).

AAQD and LAQM in the UK: critical dimensions

Analysing the implementation of EU environmental law is complex and research in the field has identified various factors that can determine compliance (Knill & Lenschow, 1998). For example, multi-level requirements can conflict with more centralised administrative traditions in some member states leading to poor policy outcomes (Gollata & Newig, 2017; Leventon, 2015, Lenschow, Becker & Mehl, 2017; Knill & Lenschow, 1998). Also, decision makers may allocate more resources, expertise or stringent interventions into particular policies or directives (Čavoški, 2017).

However, the implementation of environmental policy can also be facilitated by cross-policy linkages (Olowoporoku, *et al.,* 2012). For example, climate change and air quality policy, as “they arise from… the same sources and will therefore benefit from many of the same measures; so the combined benefits are substantially greater” (Defra 2010, p.3) (Čavoški, 2017). Equally, the joined-up policy approach of air quality management in Local Transport Plans could also make policy implementation more effective (Olowoporoku, *et al.,* 2012). However, the integration of environmental policies, either intra-departmental, cross disciplinary or otherwise, can also come with restrictions such as funding, particularly in terms of air quality policy implementation (Olowoporoku, *et al.,* 2012; Čavoški, 2017).

A comprehensive review of the EU implementation literature is beyond the scope of this paper; what is relevant for the purposes of this paper is the difference between the legal and practical implementation of EU law (Zhelyazkova, Kaya, & Schrama, 2016). Member states may be compliant by following procedures as stipulated by the directive (Héritier, 2002; Liefferink, Wiering & Uitenboogaart, 2011), however, they can still fall short of achieving the intended outcome (e.g. LAQM in the UK (Longhurst *et al.*, 2009)) (Leventon, 2015). In order to meaningfully assess practical implementation, UK LAs need an assessment tool that goes beyond a dichotomous approach to compliance, that is tailored to the UK context and that contributes to closing the policy disconnect.

In the UK, responsibility for meeting EU limit values is devolved to the national administrations, who together with Defra have produced the UK Air Quality Strategy (AQS) (Defra, 2018a; (Longhurst *et al.*, 2009).). Parallel to this, the 1995 Environment Act defines LA responsibility for local air quality (LAQM), and states that LAs are required to ‘work towards’ air quality objectives (Defra, 2018c; Beattie *et al.*, 2001; Barnes, *et al.*, 2018). If, after a review and assessment process (conveyed in the Annual Status Report (ASR)), air quality objectives are exceeded or not likely to be met, LAs have to declare an Air Quality Management Area (AQMA) and produce an Air Quality Action Plan (AQAP) with details of initiatives to be put in place to meet these objectives (Defra, 2016; 2017; Longhurst, *et al.*, 2006; 2009; 2016)

The UK approach to air quality has evolved from “an exclusively source-control approach” (Longhurst *et al.*, 2009 p. 76) in the regulation of sulphur dioxide from power stations to combat smog through the Clean Air Acts of 1956 and 1968 “to a complex but integrated, risk management effects-based process of air quality management” (ibid.) in the form of the AQS today. While air quality management was originally centralised, the Clean Air Acts supported local air pollution control coupled with a centralised national monitoring network. Since then, the collaboration between local and national government is considered the most efficient and precautionary approach in the management of air pollution, as the identification and management of local hotspots is considered best addressed at a local level (LAQM), and other elements of policy, such as fuel and engine quality standards, are addressed nationally (Longhurst *et al.,* 2009; Barnes *et al*., 2014).

While initially considered a success, over the last 21 years, LAQM has been subject to criticism due to the continued failure of the UK to meet both UK and EU NO_2 and PM_{10} targets by their 2005 (UK) and 2010 (EU) deadlines (Longhurst, *et al.,* 2016; Barnes, *et al.,* 2018, EEA, 2017; Andrews, 2015). Further, action planning to date has been relatively ineffective (Chatterton, *et al.,* 2007; Barnes, *et al.,* 2014; 2018) with few revocations of AQMAs following the implementation of AQAPs (Longhurst, *et al.,* 2016; Barnes, *et al.,* 2018).

There are many reasons behind the failure to achieve air quality objectives in the UK, spanning from the failure of Euro Standards to reduce general emissions across Europe as quickly as expected and a lack of communication and engagement across departments (e.g. public health, air quality, planning and transport) at different levels of government (Olowoporoku, *et al.,* 2012). Local decision-makers find themselves restricted in their abilities to effectively implement air quality policies as result of uncertainty as to their responsibilities, coupled with a lack of capacity and competing local policies (Barnes, *et al.,* 2014; 2018), which are manifestations of key challenges as highlighted by the literature on multi-level governance and its impact on policy outcomes.

Further, the uncertainty and assumptions made by DEFRA around emission factors for NO_2, fleet dynamics, and future projections for the UK's Air Quality Plan (or Clean Air Strategy), raise questions as to its robustness (Williams, *et al,* 2016; Moorcroft & Dore, 2013). From a policy perspective, this failure has been driven primarily by a disconnect between the LAQM and AAQD implementation processes. For example, while the AAQD monitoring requirement stipulates "at least one monitoring station per zone/agglomeration, representing a designated area (m^2) where concentrations are highest and there is relevant exposure" (Barnes *et al.,* 2018 p. 6), for LAQM "there is no legal requirement to monitor …but recommended assessment should be made at the 'worst-case' location representative of relevant exposure" (ibid.). This particular example highlights the difficulties in determining which authority, national or local, has responsibility for the differing ways of approaching the same issue.

Directly engaging with the literature on policy implementation in multi-level governance settings, this paper develops an assessment tool for better integrating and aligning LAQM and AAQD which can be used by LAs as a guide during the policy development stage and by Defra as a performance assessment tool. Our focus on integrating, within a unified assessment tool, dimensions that are critical for air quality and which operate across different levels of government offers an opportunity for LAs to systematically identify and address coordination issues, mismatches and asymmetries of information, which undermine the achievement of multi-level policy goals.

Towards a framework to assess UK local air quality policy implementation performance

Bondarouk & Mastenbroek's framework included key aspects against which to assess Dutch cities' performance. These aspects are: for Substance: Objectives and Definitional details; for Scope: Territory (or Application Area), Duration, & Addressees; for Effort: Expertise, Prioritisation, Monitoring, Staff, and Budget (or Funding).

We depart from this framework in three ways: first, the peculiarity of the UK context forces us to design an assessment tool that is robust and flexible enough to be applied to both the LAQM and AAQD regime and provide us with an overall measure of performance from a multi-level perspective. In so doing, we also specifically assess the management scale adopted by each city. This is important as the original LAQM approach designed to tackle very localised 'pollution hotspots' has been inadequate (Woodfield, *et al.,* 2002). This has led some cities to try city or regional scale AQMAs to address air quality issues more holistically which is more likely to address the transboundary nature of some pollutants and polluting activities (BCC, 2018; GMCA, 2016; Woodfield, *et al.,* 2003, 2004). This constitutes a step forward towards closing the policy gap discussed above. Second, we adopt a more holistic and integrated perspective by extending the scope of our assessment to include other substantive policy domains (local public health policies, transport policies, planning and development and energy use policies) which are drivers for effective air quality management and which will be discussed more in detail. Third, the Framework we propose allows a critical assessment of both the formal implementation of the AQAP as well as outcomes with reference to air quality targets.

The overall structure of our framework (hereafter known as The Bridging Framework) consists of three sections - Context, Output and Outcome.

1. Context

This section pertains to the circumstances around the process of LAQM and the production of AQAPs in each city. It concentrates on changes in policy and attitudes towards air quality, as well as obtaining information on the development of LAQM strategy over time. For example, knowledge of the policy successes or failures around AQAP integration into Local Transport Plans (LTP) (Olowoporoku, *et al.,* 2011), or changes in number and size of AQMA(s) (Woodfield *et al.,* 2003).

This enables decision makers to better understand the circumstances (politically, economically, etc.) under which these AQAPs were produced and therefore how they compare with others produced at different times. It also helps inform the development of policy within the city context. Further, contextualising policy by placing it within another policy area, i.e. transport, potentially improves understanding of the problem and thus facilitates implementation (Olowoporoku, *et al.,* 2010).

The 'context' section includes three aspects requiring information on the source document type and its date, the current number of AQMAs in the city, and past evidence of change.

2. Output

The Bridging Framework assesses the AQAP as a whole and the measures separately. Changes made include clarifying the scoring system and definitions, the addition of measures relevant to air quality as informed by the literature e.g. public health, and clearly distinguishes the legal stipulations of the AAQD and LAQM. The fundamental structure and scoring system remain the same as that of Bondarouk & Liefferink's framework.

In the UK, the method by which AQAP measures are implemented is at the discretion of the local authority (Defra, 2016). Our approach accommodates this leeway, attributed by article 23 of the AAQD, allowing for additional measures to be scored even if not explicitly listed in the Bridging Framework. A comments column is also supplied for explanation as required. When measures are developed, as in the case of transport, scores are broken down to give more information for analysis.

Where limited information is supplied in AQAPs e.g. around staff and funding, these aspects are applied only to the assessment of the AQAP as a whole. Further, new aspects are added to this assessment which aim to evaluate elements of overarching LAQM and AAQD polices, addressing the relevant policy disconnects outlined by Barnes, *et al.* (2018). They include measures such as policy tools, equipment specifications (e.g. monitor types), and other recommendations or stipulations surrounding LAQM such as interdepartmental cooperation (Barnes *et al.,* 2018; Olowoporoku, *et al.,* 2012). This ensures appropriate evaluation of AQAP content in light of the policy requirements of LAQM and the AAQD.

Along with transport measures, the literature points to extra measures required for evaluation (Naik, *et al.,* 2017). Specifically, public health (Brunt, *et al.,* 2016; Cannibal & Lemon, 2000), planning and development (Naik, *et al.,* 2017; Defra, 2016), and energy use and production (Jonsson & Hillring, 2006; Naik, *et al.,* 2017; Defra, 2018b). These have been added to the Bridging Framework:

Public Health Public health policy is a significant dimension when tackling air quality. A recent death and associated hospital admissions bear a striking association between spikes in air pollution and those admissions (Osbourne, 2018). Yet, there is still a disconnect between LAQM and public health policy demonstrated by the lack of obligatory health cost assessments in UK air quality policy requirements (Brunt, *et al.,* 2016; Defra, 2017). However, an integrated assessment of costs of measures and health cost savings are considered a sustainable solution (Miranda, *et al.,* 2016) and health impact assessments are being integrated into development plans (WYCA, 2015, Defra, 2018c).

Transport The literature clearly evidences that it is primarily through transport that NO_2 levels across member states are continually exceeded (EEA, 2017). And is thus a key focus in air quality literature. The Bridging Framework focuses predominantly on Transport on this basis (Bondarouk & Liefferink, 2017).

Planning and development The Planning and Development measures assess the existence of technical guidance documents showing alignment of local air quality policy with, for example, the National Planning Policy Framework (NPPF) (Defra, 2016). These should provide short term action plans for construction projects (Lewis, Shan & Hazzard, 2015). Opportunities to assess the implementation of Clean Air Zones and green infrastructure are also included (Naik, *et al.,* 2017; Abhijith, *et al.,* 2017; Barnes, *et al.,* 2018).

Energy use One of the main areas of focus of the new AQS 2018, was towards adopting the WHO standards for particulates (PM2.5) caused by the burning of biofuels as well as NO_2 derived from natural gas domestic central heating boilers, wood burners or power stations (Simkins, 2018; Defra, 2018b). Energy use and production measures assess the acknowledgement of other pollutants and sources, mitigative actions (e.g. Lo, Norton & Mannis, 2001) and integration into climate change policy (Jaramillo & Muller, 2016; Ahlers, 2016). Their inclusion acknowledges the trans-boundary nature of air pollution thus paving a potential link to policies such as Environmental Permitting Regulations and the Industrial Emissions Directive (GMCA, 2016).

These measures reflect the current political, environmental and academic conversations around air quality, reflecting where LAQM needs updating (e.g. Brunt, *et al.,* 2016) to sustainably tackle air pollution. These policy domains are assessed in the Bridging Framework.

Scores

Each AQAP measures score is systemised as a score 'out of 100'. Total Output scores are also systemised in this way. This enables easy interpretation and comparability across cities, within their AQAPs, and in relation to the set standard of the Bridging Framework itself.

3. Outcome

Bondarouk & Liefferink (2017) define policy outcome in terms of air quality improvement. However, the direct outcome of AQAPs is the implementation of its measures (Pohjola, *et al.,* 2013; Mickwitz, 2003). Both definitions are considered here. This gives insight as to AQAP purpose along with actual deliverable measures, with an eye on any causal relationship between the implementation of air quality measures and an improvement in air quality or even the achievement of AQ objectives.

Additionally, AQAP effectiveness is restricted by the limited policy obligations of LAs (Barnes, *et al.,* 2018). If AQAP measures, such as the introduction of a new bus route, are implemented, this can render, in principle, the AQAP a success. However, despite this, objectives and limit values may still be unattained (ibid.). Therefore, AQAPs could be considered an underused resource restricted by UK policy requirements even though their main function is only “to improve air quality in an AQMA” (NSCA, 2000, p.9). However, in the case of this paper they best reflect the implementation of both EU and UK air quality policy at a local level and are integral to LAQM (Bondarouk & Liefferink, 2017).

Application, measures and scoring

For the AQAP as a whole, selected elements of the documents are scored against the aspects, including pollution sources and modes, and reporting frequency. For example, ‘Objectives’ measure if national air quality requirements are being pursued (Bondarouk & Liefferink, 2017). Each aspect of the AQAP assessed is scored to a maximum of three points (see Table 1).

Equally, AQAP measures are scored to a maximum of three points (a self-defined scoring system). However, scores are made according to the quality of the AQAP measure in relation to the aspect stipulations for the equivalent framework measure. For example, under the Bridging Framework’s bicycle policy measure, specific definitional details (aspect stipulations) are given for bicycle parking (e.g. free or indoor parking). The score reflects the extent to which the AQAP measure on bicycle parking relates to those stipulations (e.g. 1 definitional detail scores 1 point; 2-3, 2 points; 4-5, 3 points). A high score would be attained if the AQAP (or supporting documents) details information on various initiatives surrounding bicycle parking (for example free and secure parking, provisions for demand, and signage for parking). A low score would reflect limited information in the AQAP or supporting documentation, suggesting that these initiatives have not been implemented or that the plan is lacking detail. AQAP measures on bicycle parking are also assessed under ‘Territory’ and ‘Duration’ aspects and are scored similarly (see Table 1).

The scores are summed to indicate a total score for the measure. Aspect scores for that measure are also totalled. Finally, total measures scores and aspect scores (which will be the same) for all the measures in the AQAP are systemised and presented. Equally, when applied to several cities, a comparison can be made between cities’ AQAPs regarding both aspects and measures (see Table 2) (Bondarouk & Liefferink, 2017).

Table 1: Example of assessment of the AQAP as a whole for various (but not all) Aspects

Aspect	***Aspect Definition***	***Aspect Specifications***	***Score***
Addressees	*Group to which the plan applies*	• *All citizens (scores 3),* • *Smaller group (scores 2),* • *Smallest group (scores 1)*	*3*
Plan Duration	*Plan duration*	• *<5 years (scores 1);* • *5 - 10 years (scores 2);* • *>10 years (scores 3)*	*2*

Application area (Formerly 'Territory')	*Geographical Scope of plan*	• *Regional (3),* • *City level (2),* • *local area (1)*	*3*
		AQAP as a whole total Score (exemplar)	***8***

Identification of case studies and data analysis

The Bridging Framework is designed and tested in relation to air quality policy and practice in five UK cities. The cities used for the application of the bridging framework are five of the six UK Core Cities, which are geographically similar in size, face similar air quality challenges (i.e. the source of the objective exceedances in each city is traffic), and have similar-sized economies (Core Cities, 2017). They are Bristol, Glasgow[1], Leeds, Manchester and Newcastle. The Bridging Framework is used to assess the following documents: Air Quality Action Plans (AQAP), Emissions Strategies, Local Transport Plans (LTP) (as assessed with comparable documents in the Netherlands by Bondarouk & Liefferink, 2017) (dated between 2009 (Newcastle City Centre AQAP) and 2018 (Leeds Transport Strategy)), and Annual Status Reports (ASRs) (2016-2018). These were the most up to date and readily available documents at the time of testing. These choices enable replication and comparability of the study supporting the reliability of the conclusions (Emmel, 2013).

The Bridging framework is designed to enable a deductive quantitative content analysis of the 'raw data' as listed above. This method is designed to measure and interpret data collected that allows judgment of implementation performance of UK cities (Schrier, 2012; Bondarouk & Mastenbroek, 2017).

Findings and analysis

Explanation of results

Table 2 summarises the results of the implementation performance assessment of the five UK city AQAPs. They detail where a city's policies may be effective (or not), in what area, and their respective progress towards improved local air quality.

From the top, the Context section shows the AQAP type, history, and the number of AQMA's in the city. This is followed by the Output assessment scores systemised into percentages so to present a clear comparison between the AQAP implementation performance scores, both within each city AQAP and across all five cities. Appendix A gives the breakdown of the AQAP Output scores and Context section. Finally, Outcome shows direct results which indicates progress made, at the time of writing, in policy action (date of

[1] Scotland, is a devolved administration, but still adheres to the UK AQS and LAQM, therefore Glasgow's AQAP will be similar to, and can be used with, the other case studies. However, for clarity, the objectives are set out in the Air Quality (Scotland) regulations 2000, the Air Quality (Scotland Amendment Regulations 2002 and the Air Quality (Scotland) Amendment Regulations, 2016 (Air Quality in Scotland, 2018).

ASR and Reported implementations), changes in air quality in the cities (Resulting air quality change, AQMA revocations/creations) and changes in NO_2 value against target levels.

Table 2: Summary results table showing the implementation performance of AQAPs in 5 cities in the UK (only Output scores have been systemised into percentages. Context and Outcome results are directly related to the criteria listed in the 'Dimensions' column).

Bridging Framework Stage	Dimensions	Bristol	Glasgow	Leeds	Manchester	Newcastle
Context	**AQAP type & history**	Joint Local Transport Plan (JLTP) 2011-2026	Glasgow City AQAP 2009	West Yorkshire Low Emission Strategy (WYLES) 2011-2026	Greater Manchester AQAP 2016-2021	Newcastle City Centre AQAP 2006 & South Gosforth AQAP 2011
	No. of AQMAs (in city)	**2**	**3**	**6**	**1**	**2**
Output	**Total AQAP Output score**	**56**	**44**	**54**	**58**	**50**
	AQAP as a whole total	65	51	57	65	53
	AQAP Measures / Aspects total	55	44	53	56	49
Output: Measures Breakdown	*Transport measures*	*73*	*53*	*55*	*75*	*70*
	Public Health	*53*	*33*	*46*	*53*	*31*
	Planning and Development	*30*	*39*	*49*	*32*	*32*
	Energy use and Production	*0*	*24*	*62*	*0*	*0*
Dimension Scores	**Substance**	56	37	51	43	51
	Scope	85	68	76	79	66
	Effort	42	33	45	62	43
Outcome	**Date of ASR**	2018	2017	2018	2017	2017
	Reported implementations	3	4	2	2	48
key for 'Resulting air quality change': 0 = no change;	**Resulting air quality change**	1	1	1	1	0

1 = improvement but continued exceedances; 2 = Improvement, pollutants below limit/objective						
	AQMA revocations	0	1	2	0	0
	AQMA Creations	0	0	2	0	0
	Highest Annual mean NO_2 value	66.8ug/m 3	65ug/m^3	95ug/m^3	66ug/m^3	61.1ug/m 3
	Difference NO_2 from limit value	26.8ug/m 3	25ug/m^3	55ug/m^3	26ug/m^3	21.1ug/m 3

Implementation performance of UK Cities

The results show both similarities and variations in implementation performance of AQAPs across the five UK cities. There is a variety of scales at which cities' have produced their AQAPs; a very local scale, e.g. Newcastle, and regional scale, e.g. Leeds. Other cities have chosen to integrate their plans within other policies, e.g. West of England Partnership's LTP. Both Transport Measures and the Scope dimension are the highest scoring. Other than this, no other correlation is made, and each city is unique in its scores. Lastly, the overall highest-scoring city is Manchester and the lowest-scoring is Newcastle, which is not necessarily reflected in the outcome results.

Analysis & Discussion

By developing a policy-informed, country-specific and integrated and systemised scoring system, this paper contributes to overcome the air quality policy disconnect between LAQM and the AAQD that exists in the UK, and in so doing, contributes to implementation literature on multi-level systems. This analysis highlights how the Bridging Framework can be used to analyse AQAPs implementation performance across an array of aspects. For example, it reflects areas of priority for LAs, and fundamentally where improvement is needed. It also enables a detailed exploration of individual cities' air quality circumstances. Finally, this Bridging Framework allows for the collation of relevant policy documents, such as ASRs, which further helps to contextualise scores. However, the application of the framework can only offer a snapshot evaluation of performance that highlights areas for integration and supports policymakers in identifying existing issues; our analysis does not explore the underlying causal mechanisms that led to these scores. Consideration of causal factors and historical trajectories would require a more in-depth within-case investigation which is beyond the scope of this paper

The breakdown of the AQAP scores provides insight into the possible factors contributing to AQAP implementation performance. For example, Manchester and Bristol have high funding scores, demonstrating greater financial potential for implementation. Manchester scores comparatively higher in Monitoring which could support a greater adherence to LAQM and AAQD policy stipulations. In general, across the cities, the lowest-scoring aspect is 'staff allocated' to the implementation of the AQAP, demonstrating a low level of relevant technically-trained human resource dedicated to air quality, irrespective of city size. However, expertise is generally well reported on, implying a good record of cross and intra-departmental cooperation in the creation of AQAPs. Scores show room for improvement across all cities' AQAPs.

The application of the framework elicited contextual information for deriving substantive comparative insights into each city's AQAP. Each city has taken a different approach to LAQM in terms of the scale at which the AQAP has been written. For example, Leeds AQAP is part of the wider West Yorkshire Low Emission Strategy (WYLES), a collaboration of several LAs across the county of West Yorkshire, and comparatively scores higher compared to Newcastle's more localised approach to each AQMA hotspot. Whilst these LAs are complying with the formal terms of LAQM, some are adopting a broader and more integrated approach than others (Bondarouk & Liefferink 2017).

Comparatively, the low AQAP scores of Glasgow's AQAP point to limited resources, in funding and expertise, available to tackle air pollution, and the relatively limited implementation area. This is reflected in the age and scale of its AQAP, which, compared to those of the other cities, is the oldest and very localised. However, Glasgow has met its legal obligations to comply with both AAQD and LAQM but this does not translate into practical changes in air quality on the ground. This is true for all the AQAP's assessed, as none of the cities have met air quality objectives (Héritier, 2002; Liefferink, Wiering & Uitenboogaart, 2011; Leventon, 2015; Longhurst *et al.*, 2009).

Bristol (and to a greater extent Leeds), as well as taking a spatially strategic approach in creating a West of England Partnership with Bath, built upon their AQAP strategy by integrating air quality with their Local Transport Plan. The high scores demonstrate the success of joined up policy (Olowoporoku *et al.,* 2012). However, Bristol's AQAP does less to address Planning & Development and omits entirely Energy Use & Production. For the latter, this reflects the differing levels of government at which policy responsibilities remain, and the resulting lack of responsibility at a local level (Olowoporoku *et al.,* 2012; Knill & Lenschow, 1998).

We have also contributed to AQ policy development by identifying the need to consistently integrate key policies (Transport, health etc) into the AQAP. For example, Energy Use and Production is not considered to be in the current scope of most cities' AQAPs, reflecting the current policy and technical guidance which focuses primarily on Transport, and Planning and Building Regulations (Defra, 2016). However, it has been updated to take a more holistic approach (Defra, 2018c). Accordingly, transport policy is prioritised with Bristol, Manchester and Newcastle scoring comparatively highly. In general, measures scores are low yet health measures are acknowledged, particularly relating to NO_2 and PM.

However, both Glasgow and Leeds do report on Energy Use and Production and Planning and Development. In the case of Leeds's AQAP, as a subsidiary of the WYLES, it further reflects the relevance of reporting on these measures due to the plans in (West) Yorkshire to install fracking power stations (WYCA, 2015; Vaughan, 2017). Likewise, Glasgow's AQAP addresses boiler emissions, reflecting an incorporation of national policy (Glasgow City Council, 2009; AECOM, 2018). Thus, the results show where some cities' policies incorporate decisions made at different tiers of governance.

Regarding Substance, Scope, and Effort, the general mid-to-low scores could reflect the level of responsibility that local authorities have in pursuing air quality targets. These, in particular, relate to Substance where the definitional details show limited research into mitigative policy measures. Scope, contrarily, shows that generally all AQAPs address the appropriate timescale, area and, social group(s). However, Effort shows a considerable lacking across the board, with scores below 50. It reflects the current policy situation where resources are not allocated sufficiently due to lack of legal obligation (Barnes *et al*., 2018, Brunt *et al.,* 2016).

While efforts to create effective AQAPs and implement them are demonstrated across the Bridging Framework scores, fundamentally, air quality objectives and limit values have not been met. Even where cities (i.e. Glasgow) have reduced the size of their AQMA(s) or reported revocations, continued declarations are made and the challenge of reducing levels of NO_2 is clearly shown by the differences between NO_2 and limit value. However, four out of the five cities' ASRs reported an improvement in air quality. This shows that current AQAPs are working to an extent, however, they could be improved to better fulfil their designated task.

By identifying areas of poor performance through the output scores, the Bridging Framework highlights the areas in which LAs and higher levels of government could better align their contributions to the AQAP's objectives. This is on the assumption that the AQAP measures are driving this improvement (not external drivers which are not influenced by LAs such as improvements in vehicle technologies). Currently disaggregating this influence is a challenge, but with effective targeted measurements this is a feasible approach to assessing the impact of many interventions.

The Context and Outcome sections added to the Bridging Framework work to consolidate the alignment of the AAQD and LAQM and frame the Output section in this context. Equally, extra measures added align the Bridging Framework with current literature, and the systematised scoring system makes the results more meaningful. The new measures secure the Bridging Framework as a relevant policy tool for current social, economic and political circumstances. They provide relevant criteria for practitioners to make an informed assessment of their cities AQ scenario and compare them against others. This could influence further efforts for action (Brunt, *et al.,* 2016; Cannibal & Lemon, 2000).

Additionally, the systemisation of scores make interpretation of the results easier as they deliver a comprehensive idea of implementation output performance of AQAPs relative to the Bridging Framework total scores (the 'standard') and a comparison amongst cities. As a result, LAs can approach the scoring either collectively or competitively which can help them develop better AQAPs. Further, the breakdown of scores enables policy makers to explore a particular area, category, or policy, to focus on, either for improvement or development. The results not only give general information on the (quality of the) contents of the AQAP but also give information beyond a comparison against other AQAPs.

The function of the Bridging Framework is to assess the performance of AQAPs and, in so doing, aligns both the AQS and AAQD in order to close the policy gap between them. Our paper therefore contributes to the literature on multi-level governance and multi-level policy implementation. It explores the consequences of multi-level governance on a specific policy area (Kleider 2020) and provides a tool that directly tackles key multi-level governance challenges such as coordination issues, mismatches and asymmetries of information. Additionally, it supports measures and aspects which reflect both policies and concentrates on where they are both practically implemented – at a local level (Barnes, *et al.,* 2018; Bondarouk & Liefferink, 2017). As a result, and considering the continued non-compliance of the cities' AQAPs, the alignment of the AAQD and LAQM in the Bridging Framework will lead to better aligned policies thus supporting LAs with their LAQM streamlining processes thus helping to close the policy gap and produce stronger environmental policy outcomes. This also addresses the "flawed subsidiarity and devolved responsibilities" (Barnes *et al.,* 2014, p. 660) causing the inefficiencies in air quality management and helps focus support on LAs to have the powers to competently manage air quality and positively contribute to the achievement of limit values (Barnes *et al*., 2014; 2018).

The applicability of our framework is not exclusive to the UK context and, as we explained, it can be adapted to analyse air quality policies in the context of other multi-level governance systems. Nonetheless, while the Bridging Framework assesses the implementation performance of cities' AQAPs it could be considered inflexible in relation to its ability to assess air quality policy at different scales, i.e., small towns, or regions. This could possibly be considered a function of the (in)consistent availability of air quality policies at these scales e.g. West Yorkshire Low Emissions Strategy vs Newcastle's 'hotspot' AQAP. On the other hand, as AQAPs are drawn up predominantly at the scale of LAs, if smaller-scale areas did not have an AQMA, an AQAP would not be available to assess. Therefore, it could be argued that the application of the Bridging Framework is restricted by the availability of policy.

The limited availability and varied content of AQAPs for cities, was a considerable limit to the extent of this study. While ASRs were readily available it was challenging to find workable documents from LA websites. Also, AQAP content is discretionary to the LA, thus the interpretation of the practitioner undertaking the assessment of the AQAP may be subjective.

The Bridging Framework currently limits its scope of assessment of Outcome to just NO_2 target values and objectives and therefore requires inclusion of all pollutants listed in the guidance documents (e.g. SO_2, PM10, PM2.5) to evidence the declaration of all AQMAs. And more information about the nature of AQMAs is required in the Context section, e.g. size and pollutant. Also, currently the existence of the Outcome section, as directed by the literature on LAQM (DEFRA, 2016), implies a causal relationship between AQAP outputs and improvement of air quality or even the meeting of objectives and limit values. While there is room for this to be researched, current data does not enable accurate assessment to support this relationship (e.g. Schoen, 2018).

The Bridging Framework's application to a larger cohort of cities in the UK is needed in order to further critically evaluate its merits, with a possible extension to other member states. It can be used to further evaluate the general state of LAQM in the UK and the approaches and resources allocated to this endeavour. More research is also required around the causal mechanisms behind the adoption of different AQAP approaches in each case and on the new measures and innovative approaches to tackling air pollution at a local level (Brunt, *et al.,* 2016).

Conclusion

This paper presented a directly actionable tool for LAs to assess the implementation of the AAQD and UK national air quality policy within their AQAPs. By doing so it contributes to reducing the policy disconnect that exists between these two policies and contributes to implementation literature in the context of multilevel systems.

This new tool assesses AQAPs and guides development of UK local air quality policy. It assesses the extent to which AQAP's comply with air quality policy as well as helping to ensure that they do. It serves as a guide and standard for LAs to develop their AQAP content and measures, encouraging focus towards the achievement of air quality objectives and limit values, and thus renders the AQAP a useful policy document. It is easily replicated in other UK cities and it is useful both in application to a single city AQAP, or many, in order to compare performance within or amongst different cities' AQAPs. The Bridging framework can also be expanded to include other dimensions, giving local authorities flexibility in how they want to assess their AQAPs.

Following Brexit and the UK departure from the EU, the UK is not under international obligation to comply with the AAQD anymore. Nevertheless, all existing EU legislation was transposed into national legislation, so the air quality regime as set up by the AAQD is still in place. This means that, at the time of writing, the UK law on air pollution remains unchanged. Should limits and objectives change in the future this Bridging Framework will remain adoptable and relevant as it assesses the implementation of solutions as opposed to these specific limits.

As is the case with most environmental problems that do not fall within the limits of well-defined administrative boundaries, tackling air pollution will require some degree of cooperation and involvement between multiple levels of government. As demonstrated in this paper, tools that help policymakers to conduct more integrated assessments of contexts, outputs and outcomes can help to address this challenge.

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Appendices

Appendix A: New Framework Test results

Table 3: Air Quality Action Plan (as a whole) Breakdown

	Objectives	Plan Duration	Definitional Details	Application Area	Addressees	Expertise	Staff	Prioritisation	Monitoring	Funding	Total (51)	Systemised Total
Bristol	4	6	1	3	3	7	0	3	1	5	33	65
Glasgow	1	5	1	2	3	6	1	2	4	1	26	51
Leeds	3	5	1	3	3	8	0	1	5	3	29	57
Manchester	2	5	1	3	3	7	2	2	8	5	33	65
Newcastle	3	6	1	1	2	7	2	1	4	4	27	53

Table 4: Context results table

Cities	AQAP Type & version history	Number of AQMAs	Evidence of historical change
Bristol	Joint Local Transport Plan (JLTP) 2006/7-2010/11 (covers both Bath and Bristol); JLTP 2011-2026 (West of England Partnership, 2011). [2018 Clean air plan strategic outline case available only (Clean Air for Bristol, 2018)].	6 in all (2011); 3 (2 Bristol and 1 Bath) (2006); Central Bristol and Bath each one extended AQMA and 4 more outside Bristol city centre	Stage 4 review and assessment sees Both Bristol and Bath AQMAs in need of extension. With further detailed investigation needed. 2004 AQAP for Bristol AQMA and Bath's one is integrated into the JLTP. 2002-2005 schemes and measures delivered aimed at promoting public transport, sustainable modes, better management of road network.
Glasgow	AQAP (2009): development of that produced in 2004 (Glasgow City Council, 2009)	3	Boundaries of the original City Centre AQMA needed increasing and new AQMAs required (2007). Transport plan developed (2014) (Glasgow City Council, 2009).
Leeds	West Yorkshire Low Emissions Strategy (2016-2021) appended by Leeds AQAP (infographic) (WYCA, 2015); Local Transport Plan & strategy (2006-2011; 2011-2026) (Leeds City Council, 2016)	6 in City of Leeds (Leeds City Council, 2018); 29 (28 NO_2 & 1 PM10) in West Yorkshire Area.	Recent improvements, proposals to revoke 2 AQMAs in 2016 and declare another 2, in Leeds (Leeds City Council, 2018).
Manchester	Greater Manchester AQAP (2016-2021); previously GM Air Quality Strategy and Action Plan (2006) developed jointly with LTP2; LTP3 developed 2011-2016 (GMCA, 2016)	1 (May 2016), reduced in size.	2001/2 AQMAs for both PM10 and NO_2. 2004/6 PM10 AQMA revoked. 2005-2006 10 AQMAs declared for whole of Greater Manchester based on modelled 35ug/m^3 isopleths for annual mean NO_2. AQMA reduced in size recently due to improvement in NOx emissions. 2016 New single AQMA declared for GM (GMCA, 2016)
Newcastle	Individual AQAPs for each AQMA. Newcastle City Centre (2006) and South Gosforth (2011) (Newcastle	2	Newcastle City centre AQMA declared in 2004, 2 more declared in 2005. Boundaries merged 2006 = 1 AQMA in the city centre. South Gosforth AQMA declared 2008 (2011 plan is 1st for this

	City Council, 2006; 2011).	AQMA) (Newcastle City Council, 2006; 2011).