Triangular Cooperation Air Quality Improvement Project

Final Activity Report

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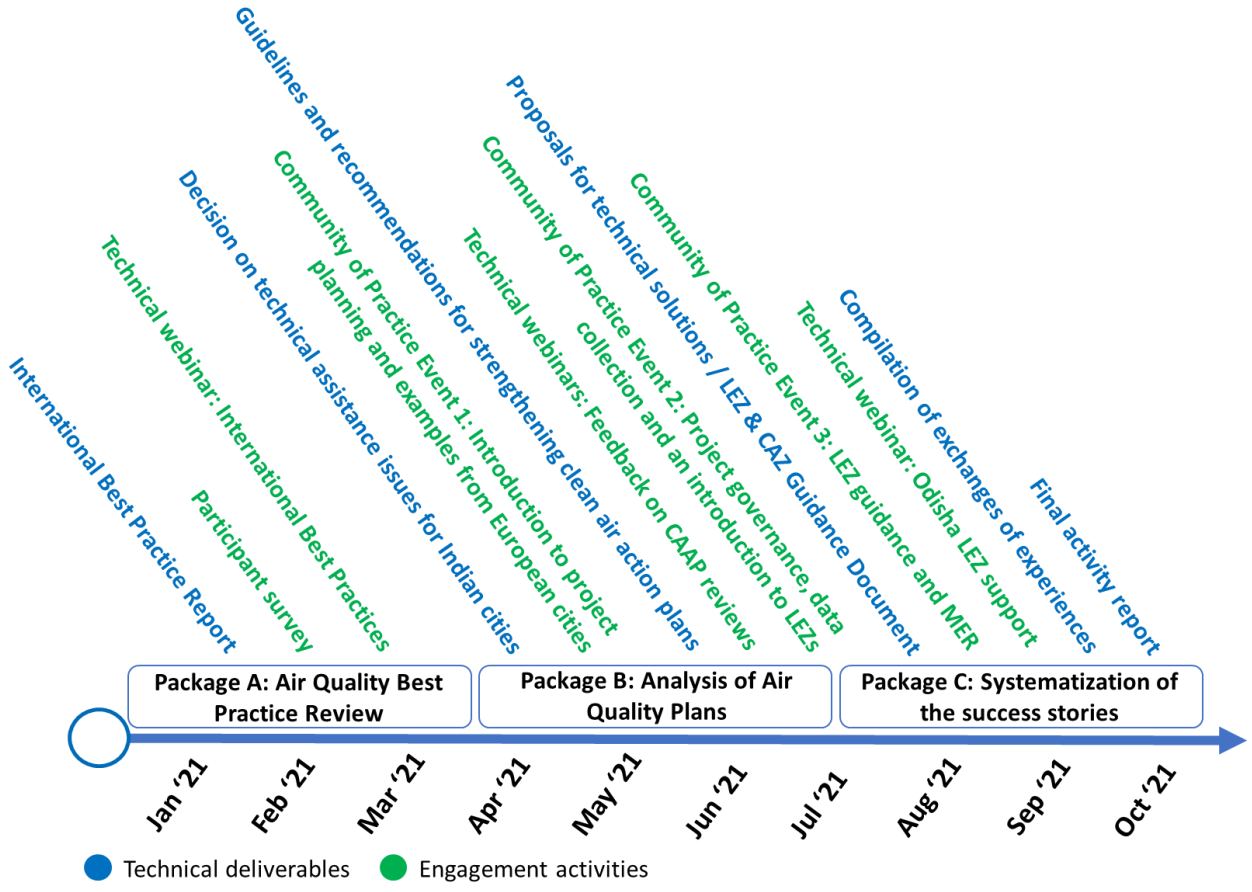
Policy Brief: Triangular Cooperation Air Quality Improvement Project

The aim of the Triangular Cooperation Air Quality Improvement Project was to strengthen the capacities of the partner cities for the development of strategies, programs, and action plans to combat air pollution, with viable technical and financial solutions. The project was delivered through collaboration between GIZ, Ricardo Energy & Environment ('Ricardo'), Hevas Innovation and the partner cities of Cuttack, Bhubaneswar, León, Salamanca, Irapuato and Celaya. Ricardo supported the project by sharing examples of best practice in air quality management, developing guidelines and recommendations for strengthening the cities' Clean Air Action Plans (CAAPs), and providing recommendations to Cuttack and Bhubaneswar for technical solutions to improve emissions from transport sources. The project was delivered through a series of written reports, technical webinars and 'Community of Practice' workshops.

The following presents a summary of the technical deliverables and engagement activities delivered through the Triangular Cooperation.

PB Figure 1: Timeline of deliverables and engagement activities under the Triangular Cooperation Project



The following considers the 'value added' through the key project milestones, including:

- The review of international best practice
- The review of Clean Air Action Plans (CAAPs)
- The technical support provided on the development of a Clean Air Zone (CAZ) or Low Emission Zone (LEZ)

- The technical webinars
- Support provided through the Community of Practice

Review of International Best Practice

The review of international best practice (Section 2.1) provides the partner cities with 45 options for measures to reduce emissions from transport and improve air quality. The report contains numerous examples of best practice from all over the world, with weblinks detailing where to find more information. A short evaluation at the end of each section scores each measure against a number of important criteria: which pollutants are affected, air quality impact, cost, co-benefits, innovation, reliance on other measures, and prospective timescale. This allows the cities to feel well-informed in making their own judgements as to which air quality measures are going to be the most applicable to their city, and have the greatest impact. It also introduces the partner cities to ambitious and cutting edge approaches to air quality management.

Review of CAAPs

The review of the CAAPs for the project cities in India and Mexico (Section 2.2) provided a clear account of the strengths and weaknesses of each CAAP. The comprehensive framework used to complete the reviews was produced using best practice for action plan development, as well as national guidance for India; the framework can also be used as a checklist for all aspects of a successful CAAP. The key findings from the reviews highlight where the priority areas for improvement are for each city, and then clear recommendations for how to make these improvements are set out. The recommendations have been prioritised based on each city's specific needs. The approach to the Triangular Cooperation was also adapted to reflect these needs.

Proposals for Technical Solutions / CAZ Guidance

The CAZ Guidance Document (Section 2.3) is a comprehensive resource that all of the cities, but in particular León and Bhubaneswar, can refer to throughout the process of implementing a LEZ / CAZ. The report acts as an instruction manual for the determination of the scope of the scheme, assessing the potential impacts, consultation with stakeholders, implementation of the project and monitoring and evaluation. Examples of best practice from other cities all over the world have been included for inspiration and further information. The Guidance Document was discussed during Community of Practice Events and during targeted technical webinars, and offers a clear framework for the establishment of the CAZs in Leon and Bhubaneswar.

Technical Webinars

During the technical webinars (Section 2.4), participants received targeted technical advice and recommendations relating to ongoing air quality actions. The webinar series began broadly, presenting examples of international best practice in air quality measures to minimise emissions from transport, but as the project evolved the webinars became much more focused on the specific needs of the cities. All webinars were interactive, meaning the participants had the chance to share their opinions and experiences, as well as ask questions of the technical experts.

Community of Practice

The Community of Practice events (Section 2.5) provided an opportunity to share ideas and experiences with other air quality professionals, hear from leading experts in the air quality field, and receive specific technical advice and recommendations relating to ongoing air quality actions. The Community of Practice lives on in the 'Breathable Cities' online platform which provides the participants with a space to stay in touch, share relevant articles, discuss the progress of their projects, access 'Learning Pill' educational videos, and continue to receive advice from the technical experts involved in the project.

Recommendations for Ongoing Air Quality Improvements

The milestones set out above have enabled the project team to identify and put forward targeted recommendations for the improvement of air quality impacts, relating to transport sources, for the partner cities in India and Mexico. These recommendations relate to improvements to strengthen the

Clean Air Action Plans in the Indian and Mexican cities, proposed short-, medium- and long-term technical solutions for air quality management in Bhubaneswar and Cuttack, and a suggested roadmap for the implementation of the LEZ in Bhubaneswar.

Systemization of Success

Feedback was received from participants of the Triangular Cooperation, collected via an online survey and during two interviews held with colleagues from the Mexican and Indian cities, on how the Triangular Cooperation has supported the development of air quality actions and to identify opportunities for future support and collaborations leading to systematization of the successes documented throughout the project. The following diagram summarises the key feedback themes collected from participants.

Based on the feedback received during the survey and interview process, there is a high level of satisfaction with the content delivered during the Triangular Cooperation project. Participants in both India and Mexico have been able to identify key areas of concern regarding air quality in their cities, followed by an exchange of experiences, ideas and technical information about solutions to these problems. The international nature of this project has allowed for participants to relate to the issues faced in cities in other countries. This includes sharing of ideas between cities which are at a similar stage in their air quality planning process, as well as learning from cities at different stages.

In order for air quality improvement to continue towards becoming an integral part of the city planning and management systems, recommendations for future systemization were also presented.

PB Figure 2: Summary of feedback on the Triangular Cooperation

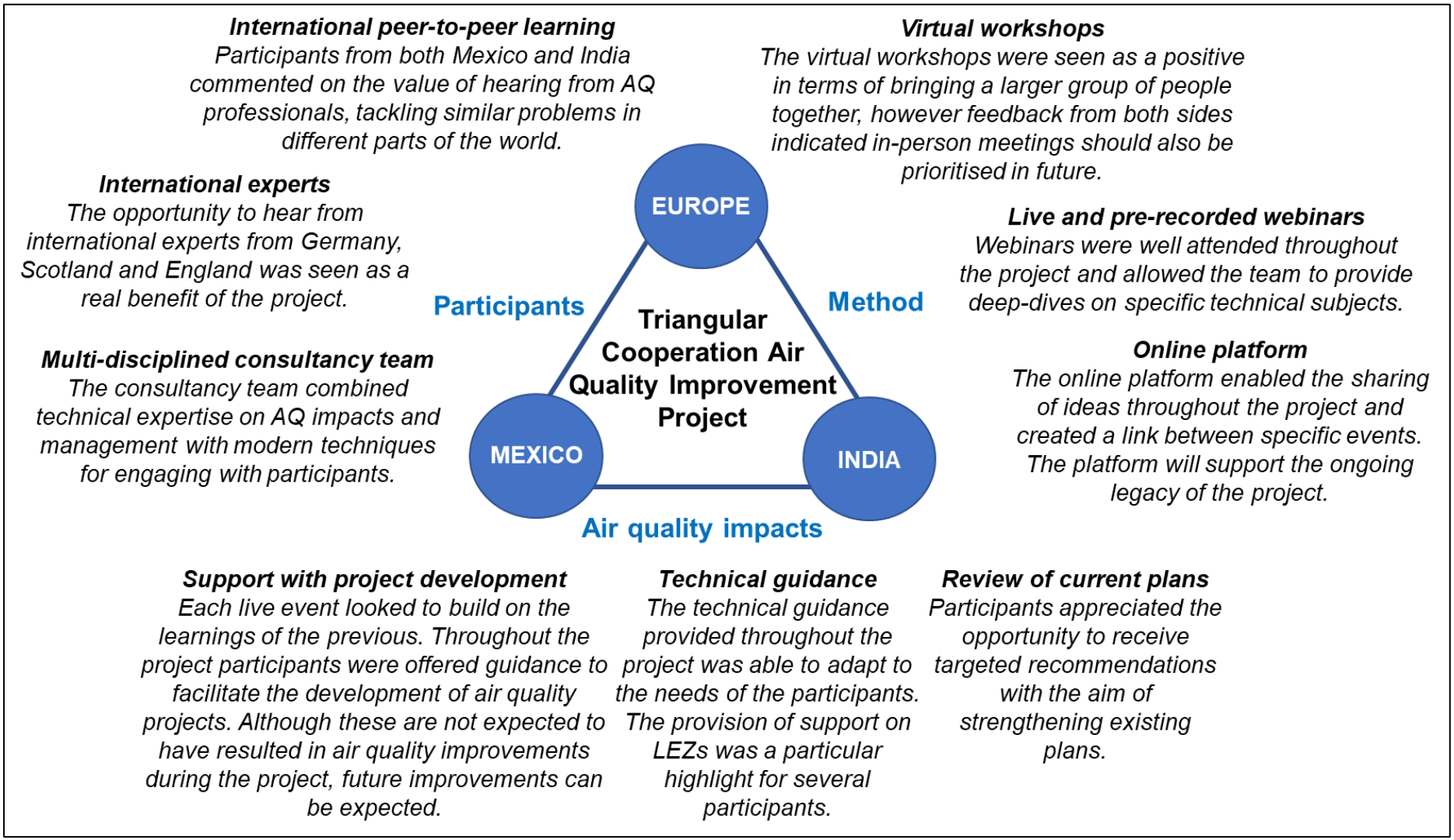


Table of Contents

Glossary

Abbreviation	Definition
AQI	Air Quality Index
CAAP	Clean Air Action Plan
CAP	Comprehensive Action Plan (list of prioritised, sector-based air quality actions within CAAPs for the Indian cities)
CAZ	Clean Air Zone
CIT	California Institute of Technology
CPCB	Central Pollution Control Board
CoP	Community of Practice
EV	Electric Vehicle
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GRAP	Graded Response Action Plan
LEZ	Low Emission Zone
LUR	Land use Regression (model)
MCA	Multi-Criteria Analysis
MCCM	Multiscale Climate Chemistry Model
MER	Monitoring, Evaluation and Reporting
NOx	Oxides of nitrogen
NO_2	Nitrogen dioxide
O_3	Ozone
OSPCB	Odisha State Pollution Control Board
PM	Particulate matter
PM_{10}	Particulate matter 10 micrometres or less in diameter
$PM_{2.5}$	Particulate matter 2.5 micrometres or less in diameter
PRTR	Pollutant Release and Transfer Registries
RAPTAD	Random Particle Transport and Diffusion Model
SEMARNAT	Ministry of Environment and Natural Resources Department for Mexico City
SO_2	Sulphur dioxide
UN	United Nations
VKRZ	Verkehrsregelungszentrale (Berlin's state-of-the-art traffic control centre)
WRF	Weather Research and Forecasting (model)
ZEZ	Zero Emission Zone
ZML	Léon Metropolitan Area

1 Introduction

Air pollution causes and exacerbates a number of diseases, ranging from asthma to cancer, pulmonary illnesses and heart disease. Outdoor air pollution and particulate matter, one of its major components, have been classified as carcinogenic to humans by the International Agency for Research on Cancer. In 2016 air pollution was the second largest risk factor causing non-communicable diseases globally, after tobacco smoking. 24% of stroke cases, 25% of ischaemic heart disease, 28% of lung cancer, and 43% of chronic obstructive respiratory disease are attributable to ambient and household air pollution. In India alone, air pollution accounted for approximately 1.2 million deaths in 2017.

The Triangular Cooperation Air Quality Improvement Project has been led by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and supported by Ricardo Energy & Environment (Ricardo) and Hevas Innovation. The project has aimed to facilitate the sharing of information and expertise on the management of air quality in urban environments, between cities in India, Mexico and Europe, with a focus on transport emissions.

1.1 Project overview

The cities partnering in this project include Cuttack and Bhubaneswar in Odisha State, India, and León, Salamanca, Celaya, and Irapuato in Guanajuato State, Mexico. Representatives of a selection of European cities have also participated in the project, through the sharing of ideas, experiences and recommendations.

The aim of the project was to strengthen capacities for the development of strategies, programs, and action plans to combat air pollution, with viable technical and financial solutions. The three fields of action for the project are:

- Knowledge Exchange – Development of technical capabilities for improving air quality through facilitating knowledge exchange.
- Technical Support – Planning and implementation of clean air measures through technical support.
- Capacity Building – Capacity building for replication in the Indian cities.

The project was delivered through collaboration between GIZ, Ricardo, Hevas Innovation and the partner cities. Ricardo supported the project by:

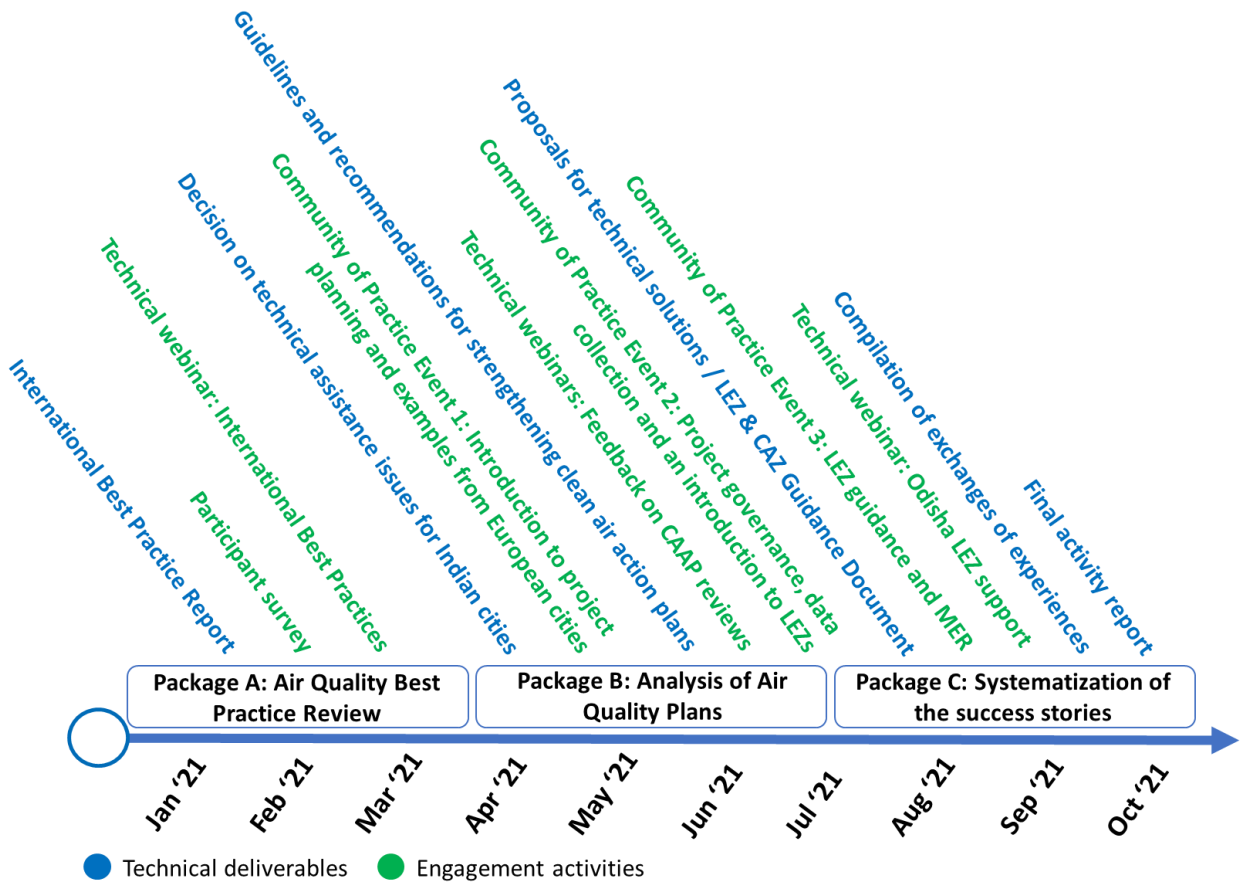
- Sharing examples of best practice in air quality management;
- Developing guidelines and recommendations for strengthening the cities' Clean Air Action Plans (CAAPs); and
- Providing recommendations to Cuttack and Bhubaneswar for technical solutions to improve emissions from transport sources.

The project has been delivered in three packages:

- Package A: Air quality best practice review
- Package B: Analysis of air quality plans
- Package C: Systematization of the success stories implemented in India and Mexico

Figure 1 provides a timeline of the technical deliverables and engagement activities provided throughout the Triangular Cooperation Project. NB: This diagram only reflects the activities in which Ricardo were involved – the project also involved other activities delivered by project partners, which may not be reflected in this diagram.

Figure 1: Timeline of deliverables and engagement activities under the Triangular Cooperation Project



1.2 Purpose of this document

This report presents the key milestones of the Triangular Cooperation Air Quality Improvement Project, including:

- The review of international best practice
- The review of Clean Air Action Plans
- The technical support provided on the development of a Clean Air Zone (CAZ) or Low Emission Zone (LEZ)
- The technical webinars
- Support provided through the Community of Practice

For each, consideration is given to what support was delivered and how this has contributed to the program as a whole.

The report provides a summary of the technical recommendations put forward for all participant cities, including suggestions for improving the Clean Air Action Plans (India and Mexico) and recommendations for technological improvements (India). The report also presents the findings of a review of participant feedback on the project and highlights the areas in which the project has proved most beneficial and opportunities for future improvement and expansion.

2 Project milestones and achievements

2.1 Review of international best practice

Ricardo completed a review of international best practices for managing and improving pollutant emissions from urban transport. The review identifies examples of good practice across 45 transport-related air quality measures in the following categories:

- Direct emission control
- Fuel switching
- New technologies
- Mode shift
- Transport and urban planning
- Air quality monitoring and data
- Communication and engagement

Priority action areas

The measures within each group were evaluated to determine which air quality actions are most likely to be beneficial for the participant cities in the Triangular Cooperation Project. The priority action areas identified include:

- **Direct emission control measures**

  Direct emission control measures, such as emissions standards, anti-idling campaigns, smoky vehicle enforcement schemes and low emission zones, aim to directly remove transport emissions before they are emitted. They can have an impact on air quality in a relatively short timescale, and in general, can be implemented independently (i.e., without the need for various supporting measures), although they can be costly to put in place. These measures have the potential to be effective for the partner cities under the Triangular Cooperation Project as they will directly target the most polluting vehicles in short space of time, however there are likely to be challenges associated with their implementation and careful planning and assessment will be required.

- **Fuel switching measures**

  This category has a focus on cleaner technologies, but not necessarily the newest technologies (i.e. electric vehicles) because cities or individuals may not be in a position to afford an electric vehicle or vehicle fleet. Cleaner vehicles of other types, like higher Euro standards, hybrid vehicles or retrofitting options also reduce pollutant emissions compared to 'traditional' diesel vehicles. Fuel switching measures are likely to be particularly effective for the partner cities under the Triangular Cooperation project because they do not yet have the infrastructure for EVs, nor the funding to be able to afford the newest technologies. Retrofitting vehicles is sustainable because it means that the current fleet of buses / taxis / etc. does not go to waste – the same vehicles can be kept, but the emissions can still be reduced. In time, the cities may then progress towards ‘new technologies’.

- **New technologies**

  ‘New technologies’ measures include the more recent developments to reduce emissions from transport, including electric vehicles, other alternative fuels and 'active dust binding'. These types of measures are innovative and effective, however, there are challenges for cities such as those in the Triangular Cooperation because of the high costs. In addition, the measures may rely on infrastructure that the project cities do not have yet. This means that the timescale for implementation of new technologies is likely to be relatively long, and therefore, the impacts on air pollution will not be seen for even longer.

- **Mode shift measures**

  Mode shift measures change a person's mode of transport from a private vehicle to another mode of transport – for example to public transport, cycling, walking, or car sharing. No matter the stage a city is at in terms of its mobility, all cities should be aiming towards better mode shift – even the examples of best practice are constantly striving for improvement. For each partner city, the possible combination of modes of transport will be different, but in general the actions that are successful in shifting journeys away from the private vehicle are: improving public transport infrastructure and service quality, offering discounted and intermodal tariffs, improving the footpath and cycle networks, providing priority bicycle routes or junctions and bike rental services, and providing services for municipal and corporate mobility management. Although mode shift measures often rely heavily on other measures, they also tend to offer important co-benefits such as improved quality of life, reduced commuting stress, and improved health / fitness from uptake of active travel.

- **Transport and urban planning measures**

  In general, these measures decrease emissions of pollution from transport by smoothing the flow of traffic; stop-start traffic releases more emissions than travelling smoothly at a continuous speed. The measures fall into two categories: those targeting moving traffic (such as dynamic traffic management, truck routeing, traffic flow smoothing, and speed limits), and those targeting stationary traffic (which mainly focus on parking, like controls or a guidance system). Transport and urban planning measures mostly have a low reliance on other air quality measures, and provide quite a few co-benefits. As there is such a mix of measures, they vary between being costly or cheap, innovative or not, and the prospective timescales also vary significantly. For the partner cities under the Triangular Cooperation, with such a diverse range of transport and urban planning measures available, there will be a measure or combination of measures to suit each city.

- **Air quality monitoring and data measures**

  Collection of air quality monitoring data is vital to understand the air quality situation in a city, including which pollutants are the biggest problem, where the pollution hotspots in the city are, and who is exposed to pollution. The data can also be used to help raise awareness with the public. Although these measures have a low impact on air quality on their own (as they do not directly impact emissions of pollutants from transport), they support the implementation of nearly every other air quality measure, benefit from low costs, and are quick to implement. It has been identified during the 'strengthening CAAPs' portion of this project that all of the project cities need to strengthen their CAAPs; a good basis for this begins with improvements to the air quality monitoring work and other data (such as mobility, fleet information, etc.).

- **Communication and engagement measures**

  Communication and engagement measures aim to inform the public about air pollution and what opportunities they have to improve air quality. These measures include promotional actions, for example to promote park & ride or bike & ride services, electric vehicles, cycling, or alternative mobility options in general. It also covers educational measures such as air quality displays, dynamic passenger information systems and informing the public about rules or regulations relating to air quality measures like clean air zone charges. As with air quality monitoring and data measures, communication and engagement measures have a low impact on air quality, as they do not directly impact emissions of pollutants. However, they tend to be low-cost, quick to implement, and support the implementation of other measures. This is of particular importance to León and Bhubaneswar who are working to implement Low Emission Zones or Clean Air Zones – communication and engagement measures will be vital in ensuring the successful implementation of these schemes.

The findings of the international best practice review, and the recommendations for priority action areas, were presented at a technical webinar for all participants, held in February 2021.

Identification of best practice case studies and expert speakers

The review highlighted several examples of best practice approaches to managing transport emissions in urban environments, which enabled the project team to identify potential expert speakers to participate in the engagement events. The speakers were selected to provide a more in-depth understanding of key success factors for effective interventions, and those that may be recommended for implementation as part of the Triangular Cooperation Project.

The European cities asked to participate in the Triangular Cooperation included:

- ***Hamburg*** – the 'gold standard' in terms of air quality measures and associated infrastructure. The city has a well-established EV charging infrastructure, including public transport as well as private vehicles. The most recent "Master Plan for Designing More Sustainable and Emission-Free Mobility in Hamburg" contains further measures to expand electromobility, such as continued expansion of the electric bus fleet and procurement regulations for other modes of transport. Of particular interest is also the bilateral mobility partnerships that have been agreed with companies including Volkswagen, BMW, and Daimler, as well as Hamburg's role as host of the Intelligent Transport Systems World Congress in October 2021.
- ***Berlin*** – the city has a wide range of measures that contribute to air quality improvements and demonstrate best practice. Berlin's state-of-the-art traffic control centre (Verkehrsregelungszentrale, VKRZ) is responsible for monitoring and manually activating traffic light systems at 2,000 intersections in Berlin, for operating Variable Message Sign systems on motorways, for monitoring the traffic situation on over 1,500 km of roads, and for transmitting traffic information from the regional reporting office – these actions all help to keep the flow of traffic in the capital smooth, and reduce transport emissions. Another area of interest is cycling; Berlin has improved the cycling infrastructure through large increases in funding, and demonstrated the importance of cycling by increasing cyclists' representation in the Senate. There are an increasing number of protected bicycle lanes that separate cyclists from automobile traffic – these green lanes help improve safety with their visibility and can be quickly installed. Another interesting measure is the use of e-cargo bikes for 'last mile' delivery, which was trialled during a temporary project (KoMoDo); approximately 120 e-cargo bikes are now available to rent under the 'fLotte kommunal' scheme run by the German Bicycle Club Berlin e.V. (ADFC Berlin).
- ***Oxford*** – a leading example of air quality management practices in the UK. The city has developed a range of measures as part of their Low Emission Strategy to support air quality improvements, notably in the areas of freight traffic management, expansion of zero emission vehicle uptake and developing public transport. Oxford City Council has installed electric charging points in and around the city to encourage use of electric vehicles, and is currently developing a pilot Zero Emission Zone.

How has the review of international best practice contributed to the success of the Triangular Cooperation?

The review of international best practice provides the partner cities with 45 options for measures to reduce emissions from transport and improve air quality. The report contains numerous examples of best practice from all over the world, with links detailing where to find more information. A short evaluation at the end of each section scores each measure against a number of important criteria: which pollutants are affected, air quality impact, cost, co-benefits, innovation, reliance on other measures, and prospective timescale. This allows the cities to feel well-informed in making their own judgements as to which air quality measures are going to be the most applicable to their city, and have the greatest impact.

2.2 Review of Clean Air Action Plans

2.2.1 Approach to the review

Ricardo undertook a review of the Clean Air Action Plans (CAAPs) prepared by the partner cities in Mexico and India, providing an appraisal of air quality management practices in each city, setting out recommendations for strengthening each CAAP and identifying key areas for technical support.

To complete an appraisal of the CAAPs, an appraisal framework was developed based on national guidance for India, as well as international best practice for action plan development. This framework was based on the following components:

- *Understanding the air quality problem* – What data has been collected and analysis carried out to understand the level and sources of air pollution in the city, and activities driving this?
- *Developing improvement options* – How were the actions in the plan developed? How do they relate to the underlying evidence on understanding the problem? Which stakeholders were involved and what level engagement was carried out?
- *Assessment of the options* – How have the options been assessed for their impact and viability? Has modelling been carried out to assess air pollution improvements? Has a financial assessment been carried out? Were wider factors considered? Was any kind of prioritisation carried out to focus on the key actions that are likely to have the most benefit?
- *Developing the action plan itself* – Have a clear set of justified actions been developed from the previous steps? Is the responsibility for each action clearly defined? Have the costs of each action been identified? Has an implementation schedule been developed? What monitoring of the action plan is in place?

The appraisal framework providing evidence from each CAAP under six key areas:

- Understanding the problem
- Setting improvement targets
- Options development
- Assessment of options
- Development of the Action Plan
- Monitoring and review

Within each key area, a range of criteria were created from which to assess the CAAPs against. The CAAPs were rated against each criterion as either: red (the criteria has not been fulfilled at all), amber (the criteria has been fulfilled to an extent, but it is not adequate) or green (the criteria has been fulfilled and to a good standard), and evidence provided to explain why this rating was given. The ratings were then used to provide an overall score for the CAAP out of ten, for that assessment area.

A separate discussion on observations of the air quality management system in each city, was also provided, based on four interconnecting themes that are used in India to manage air quality in urban areas: infrastructure development, capacity building, studies and research, and outreach and citizen empowerment. This section used information gathered from interviews and technical webinars with relevant stakeholders, as well as the CAAP review for each city, to identify the key challenges and barriers facing the air quality management systems in the cities.

2.2.2 Key findings

The findings of each CAAP appraisal are summarised below. The recommendations for improving air quality management can be found in Section 3.1.

The CAAPs for Cuttack and Bhubaneswar are largely the same, as the plans are produced at the state (Odisha) level and the Comprehensive Action Plans (CAPs; list of air quality actions) are unique to each non-attainment city in the state. This means that the key findings from both action plans are relatively similar, although there was more information available for Bhubaneswar, meaning the CAAP scored more highly than Cuttack in a couple of the key appraisal areas.

Cuttack & Bhubaneswar

Table 1: Summary of the review of the Cuttack and Bhubaneswar CAAPs

Key assessment area	*Criteria not fulfilled at all*	*Criteria fulfilled to an extent, but it is not adequate*	*Criteria fulfilled and to a good standard*
Understanding the problem	No continuous monitoring stations are present. No meteorological data provided. No source apportionment study is available. No modelling has been completed to forecast a baseline air quality scenario.	Some information available on context and activity. An emissions inventory is available. Some health data provided at the state level, and global studies acknowledged. Air quality monitoring is in place, but number of stations is not adequate. Some acknowledgement of transboundary pollution and key polluting sectors.	
Setting improvement targets	The NCAP target to reduce air pollution by 20-30% by 2024 has not been acknowledged in the CAAP. It is unclear whether the targets in the plan are binding, when they need to be met, and what the consequences are if they are not met. No sector-based targets are clearly defined in the CAAP.	Baseline pollutant concentrations have been calculated based on methodology used by the USEPA, however, monitoring data feeding into this could be improved.	Pollutant reduction targets for PM are clearly set out. The compliance gap to achieve the NAAQS has been calculated.
Developing options	There are no plans for implementation of actions provided.	Further inspiration could be taken from best practice in other cities / countries in developing the plan and air quality actions. As there is no modelling to determine the level of impact on air quality each measure will have, it is unclear whether the number / range of actions is appropriate to address the exceeding pollutants and their magnitude. As there is no source apportionment information, it is unclear whether the number and magnitude of actions under each sector is appropriate to the sector's share of emissions. The emissions inventory provides a small indication of this.	The NCAP and existing actions at the state level have been considered when developing the plan. The Air Quality Monitoring Committee that developed the plan contains representation from a number of relevant departments. The authority/authorities responsible for the implementation of each air quality action have been identified.
Assessment of options	No modelling of impacts on activity, emissions or air quality has been completed. The cost-benefit / cost-effectiveness of the measures has not been considered. No assessment of the potential wider economic, social, environmental and political impacts has been completed.		

Key assessment area	*Criteria not fulfilled at all*	*Criteria fulfilled to an extent, but it is not adequate*	*Criteria fulfilled and to a good standard*
Development of the overall action plan	The practicability and technical feasibility of the actions have not been assessed. No evidence has been provided to demonstrate the prioritisation process, as no modelling of air quality actions has been completed. No assessment has been made as to whether the overall plan will result in the air quality objectives being attained. Although approximate timescales for each measure have been provided, there is no mention of specific dates for actions to be completed / any targets to be met. The expected cost of implementation and/or maintenance of each of the actions has not been presented.	The requirement for inter-departmental / regional coordination and alignment have been identified, but not specifically for each action. Multiple responsible agencies have been listed by each action where appropriate. General sources of funding have been secured according to the CAAP, but these are not listed, nor assigned to each measure.	The CAAP has been developed by the cross-department Air Quality Monitoring Committee and they will oversee its implementation. CAP actions are presented, by sector, in a table. The plan lists the actions by priority under each sector. The agency/agencies responsible for each action have been identified.
Monitoring and review	No mechanism for assessment of the impact of the implemented measures has been presented. No mechanism / framework for regular review of the plan's overall progress has been presented.	The plan acknowledges the need for sufficient indicators to monitor progress of each air quality action and for evaluation, but these have not been presented. It is clear that the plan is expected to be updated as further information becomes available, but it feedback from the implementation stage should also be taken into account.	

The review of the Cuttack and Bhubaneswar CAAPs highlighted several areas for potential improvement, including the introduction of new continuous monitoring stations, the use of modelling to create a baseline and forecast future pollution levels, the introduction of sector-based targets, and the use of more detailed planning for the implementation of the actions. Furthermore, it is recommended an assessment be made as to whether the proposed actions are likely to achieve NCAP targets, and if not, by when these targets are expected to be met. However, the review did also identify a number of strengths in both CAAPs, including the identification of relevant departments and organisations responsible for implementation of actions, the establishment of the Air Quality Monitoring Committee and the prioritisation of actions under each sector.

Léon Metropolitan Area (ZML) and Salamanca, Celaya, and Irapuato

Table 2: Summary of the review of the Cuttack and Bhubaneswar CAAPs

Key assessment area	*Criteria not fulfilled at all*	*Criteria fulfilled to an extent, but it is not adequate*	*Criteria fulfilled and to a good standard*
Understanding the problem	No acknowledgement of transboundary pollution. No modelling has been completed to forecast a baseline air quality scenario.	Some acknowledgement of regional background sources.	Information available on context and activity. Some health data provided at the state level, and global studies acknowledged. Air quality monitoring is in place.

Key assessment area	*Criteria not fulfilled at all*	*Criteria fulfilled to an extent, but it is not adequate*	*Criteria fulfilled and to a good standard*
			Meteorological data provided. Emissions inventory / source apportionment study is available. Acknowledgment of local sources of pollution and key polluting sectors.
Setting improvement targets	It is unclear whether the targets in the plan are binding, when they need to be met, and what the consequences are if they are not met. No sector-based targets are defined.	Pollutant reduction targets for PM based on concentrations are not clearly set out.	The results from modelling exercises are provided. Current compliance with Official Mexican Standards are clearly highlighted.
Developing options	There are no plans for implementation of actions provided.	Further inspiration could be taken from best practice in other cities / countries in developing the plan and air quality actions. Justification is provided for each measure within the ProAire. However, as there is no modelling to determine the level of impact on air quality each measure will have, it is unclear whether the number / range of actions is appropriate to address the exceeding pollutants and their magnitude.	The actors involved in ProAire that developed the plan consist of representation from a number of relevant departments. The authority/authorities responsible for the implementation of each air quality action have been identified. Source apportionment information is provided, and the number and magnitude of actions under each sector appears to be appropriate to the sector's share of emissions.
Assessment of options	No modelling of impacts on activity, emissions or air quality has been completed. The cost-benefit / cost-effectiveness of the measures has not been considered. No assessment of the potential wider economic, social, environmental and political impacts has been completed.		
Development of the overall action plan	The practicability and technical feasibility of the actions have not been assessed. No evidence has been provided to demonstrate the prioritisation process, as no modelling of air quality actions has been completed. No assessment has been made as to whether the overall plan will result in the air quality objectives being attained. Where multiple organisations have been identified as responsible for measure implementation, the specific actions of each have not been presented.	The plan does not list the actions by priority under each sector. The requirement for inter-departmental / regional coordination and alignment has been identified in the plan, but not specifically for each action. Multiple responsible agencies have been listed by each action where appropriate. A timeline for each action within a measure is given, however, there are no start/end dates, and timelines are vague. General sources of funding have been identified, but these are not listed, nor assigned to each measure.	The implementation of ProAire will be overseen by COAIRE. The agency/agencies responsible for each action have been identified. ProAire has been communicated for public feedback and is available in the public domain. Each measure has a set of sub-actions and the responsible agency/agencies, as well as approximate timelines, have been identified.

Key assessment area	*Criteria not fulfilled at all*	*Criteria fulfilled to an extent, but it is not adequate*	*Criteria fulfilled and to a good standard*
		The expected cost of implementation and/or maintenance of each measure has been presented, but not for each of the actions.	
Monitoring and review	No mechanism for assessment of the impact of the implemented measures has been presented.	It is clear that the plan is expected to be updated as further information becomes available, but feedback from the implementation stage should also be taken into account.	A framework for regular review of the plan's overall progress has been presented. The plan acknowledges the need for indicators to monitor progress of each air quality action, and these are presented for each action.

The review of the Léon Metropolitan Area and Salamanca, Celaya, and Irapuato CAAPs highlighted a number of strengths in both CAAPs, including air quality monitoring data, meteorological data, source apportionment and health information providing a good basis for understanding the problem, the identification of relevant departments and organisations responsible for implementation of actions, and COAIRE overseeing the implementation of ProAire. However, there are several areas for potential improvement, including the use of modelling to assess the likely impact of proposed air quality actions on pollutant levels, then prioritise the actions in the CAAPs based on this information (and other impact assessments). It is also recommended that mobile sources (i.e. transport) are allocated additional and stronger air quality actions in both CAAPs; transport is identified as one of the most polluting sources in both plans, yet there are few actions targeting transport and they are defined relatively vaguely. The use of more detailed planning for the implementation of actions would support all of the above.

How has the review of the CAAPs contributed to the success of the Triangular Cooperation?

The review of the CAAPs for the project cities in India and Mexico provided a clear account of the strengths and weaknesses of each plan. The comprehensive framework used to complete the reviews was produced using best practice for action plan development, as well as national guidance for India; the framework can also be used as a checklist for all aspects of a successful CAAP. The key findings from the reviews highlight where the priority areas for improvement are for each city, and then clear recommendations for how to make these improvements are set out. The recommendations have been prioritised based on each city's specific needs. The approach to the Triangular Cooperation was also adapted to reflect these needs.

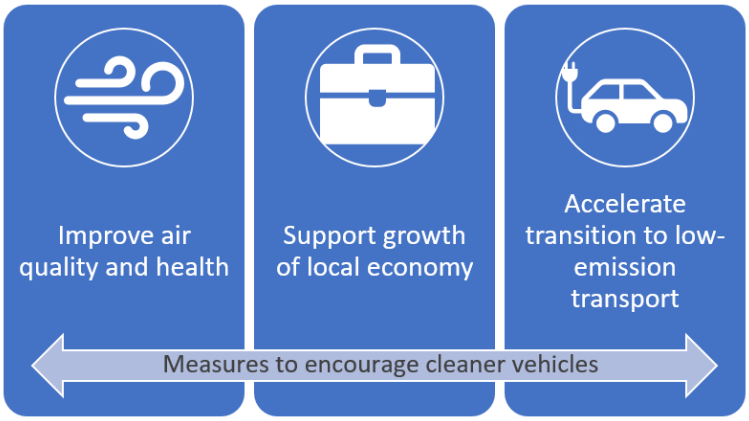
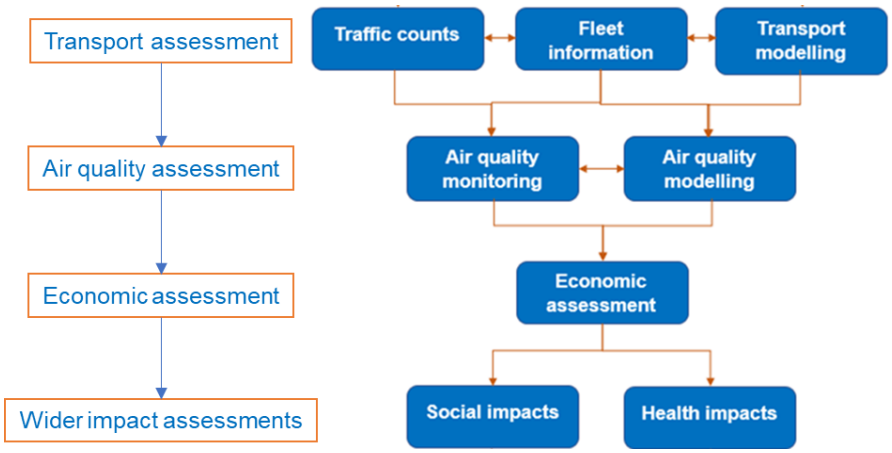
2.3 CAZ guidance document

Through the course of the project the partner cities identified the introduction of a Clean Air Zone (CAZ) or Low Emission Zone (LEZ) as a preferred approach to improving air quality. In support of this, Ricardo prepared a CAZ Guidance Document which set out recommendations for the development and implementation of a CAZ.

This guidance document can, in theory, be used by any city as an instruction manual on how to implement a Clean Air Zone. At each stage of the planning and implementation process, the different options and decisions that can be taken are outlined. This enables the city to make an informed decision based on the local circumstances, data, time, and funding available. Of particular importance are the 'decision tree' and the checklist in the full report – both these resources should be used when implementing a CAZ as a way for cities to map out their projects and keep track of progress.

The key sections of the CAZ document are set out below.

Table 3: Contents of the CAZ Guidance Document

Section	Description
What is a Clean Air Zone?	Provides a description of what a Clean Air Zones, and other zones, such as Low Emission Zones and Zero Emission Zones, are trying to achieve. Describes the difference emissions standards-based zones and access management zones. 
Defining the scope of a CAZ	Outlines the five main considerations when defining the scope of a CAZ: • Pollutants targeted – the main ones being PM, NOx / NO_2, SO_2, O_3 • Scope of restrictions – the importance of balance when considering the scope of the CAZ, covering: the types of vehicles, emissions standards, boundary/ies of the zone, time of day, levels of charging, exemptions, and introducing a CAZ • Legal basis – explains prescriptive / regulatory mechanisms vs financial / charging mechanisms • Enforcement – provides examples of physical, manual and automatic enforcement • Supporting measures – sets out impactful supporting measures under three categories: informative measures, management measures, and support for vehicles / alternative transport This section in particular provides a variety of case studies and examples with links to where the reader can find more detailed information.
Assessing the potential impacts of a CAZ	Briefly describes the importance of each impact assessment, the data required, what the results of each assessment can be used for, and how the assessments relate to each other. 

Section	Description
Consultation	Outlines the benefits of early engagement in the planning of a CAZ, and provides information on the four groups of stakeholders that should be targeted for consultation: politicians, residents, businesses, and heritage / tourism stakeholders, including what their main concerns are likely to be.
Implementation	Introduces the eight characteristics of good governance (according to the United Nations, UN), and emphasises the importance of cooperation across multidisciplinary teams, using the Bristol (UK) CAZ as a case study. Sets out five examples of monitoring metrics: air pollutant concentrations, emissions measurements, fleet composition surveys, traffic counts, and active travel surveys. Highlights the importance of a system for Monitoring, Evaluation and Reporting (MER) to track the performance of the CAZ over time.

How has the CAZ guidance document contributed to the success of the Triangular Cooperation?

The CAZ Guidance Document is a comprehensive resource that all of the cities, but in particular Leon and Bhubaneswar, can refer to throughout the process of implementing a LEZ/CAZ. The report acts as an instruction manual from determine the scope of the scheme, assessing the potential impacts, consultation with stakeholders, implementation of the project and monitoring and evaluation. Examples of best practice from other cities all over the world have been included for inspiration and further information.

2.4 Technical webinars

Ricardo provided a series of technical webinars in support of the Triangular Cooperation, to present the findings of the international best practice review, the outcomes of the reviews of the CAAPs and to set out specific recommendations on the implementation of the proposed LEZ in Bhubaneswar.

Table 4: Technical webinars delivered in support of the Triangular Cooperation Project

Webinar	Description
International Best Practice Webinar	Following the production of the International Best Practice Report, Ricardo summarised the findings with a presentation for participants from India and Mexico, covering key themes, effective short- and long-term actions and considerations for implementation. Participants were given an opportunity to share experiences of what has been achieved in their cities to date and challenges faced. The event took place on 18th March 2021. Three breakout groups were used to separately discuss the topics of communication and engagement, new technologies, and mode shift.
CAAP Review Webinars	Results were presented to participants following a review of the CAAPs for Cuttack and Bhubaneswar, and of the Management programs to improve air quality for the cities in Guanajuato (León, Salamanca, Celaya, and Irapuato). Findings from the initial assessment were presented and discussed with representatives from the cities. Separate presentations were given to the participants from India and Mexico, with a summary of the methodology for the assessment and a discussion of findings and key gaps for each assessment area
Bhubaneswar CAZ / LEZ Webinar	A technical webinar was provided to representatives of Odisha State on the proposed Low Emission Zone for Bhubaneswar. A review of Odisha's progress in developing an LEZ was presented by Ricardo, followed by a proposed roadmap for developing the Bhubaneswar LEZ. The webinar involved a plenary discussion on the proposed site for the

Webinar	Description
	LEZ, the project team, the needs for assessment and potential benefits for improving air quality and local tourism.

How have the technical webinars contributed to the success of the Triangular Cooperation?

During the technical webinars, participants received targeted technical advice and recommendations relating to ongoing air quality actions. The webinar series began broadly, presenting examples of international best practice in air quality measures to minimise emissions from transport, but as the project evolved the webinars became much more focused on the specific needs of the cities. All webinars were interactive, meaning the participants had the chance to share their opinions and experiences, as well as ask questions of the technical experts.

2.5 Community of Practice

The Triangular Cooperation was supported throughout by the establishment of a Community of Practice (CoP) between the representatives of the partner cities. The CoP platform was set up by Hevas Innovation under the terms of a separate contract. Hevas have also been responsible for managing access to the CoP and curating content on the platform.

The 'Breathable Cities Community of Practice' was set up with the intention to interact openly, collectively and creatively to generate knowledge and create new realities through a virtual space to share information, case studies and projects. This has been implemented through a series of webinars, live gatherings, a programme of 'learning pills' and the online platform *breathablecities.live*, as summarised in **Figure A. 1** in Appendix A1. The Community of Practice has been given the title 'Breathable Cities' to reflect the objective for cities to be able to combat air pollution more effectively.

Table 5: Summary of Community of Practice Events

Event	Description
Community of Practice Event 1: Introduction to Project Planning and Examples from European Cities 25th – 27th May 2021	The event focused on the theme of 'best practices', covering the topics of communication and engagement, principles of project development and examples of best practice from Hamburg, Germany and Oxford, England. **Day 1** included a technical presentation from Ricardo on the role of communications and engagement in improving air quality, followed by an interactive session where participants considered how communication and engagement can support air quality management. **Day 2** focused on the experiences of the European cities Oxford, Hamburg, and Berlin, with presentations from the European experts followed by a 'Fishbowl' activity, during which the audience were able to ask questions. Group discussions were used to reflect on the most important elements learned from the European cities. **Day 3** introduced the process of project design, with Ricardo presenting some key elements to be considered in project design such as identification of options, strategy, stakeholders, metrics and financing. This was followed by activities where the participants mapped the possibilities of their projects, and the stakeholders involved.
Community of Practice Event 2: Project Governance, Data	Covered the themes of project governance and Low Emission Zones, with technical guidance and examples from Dr Guy Hitchcock and Martin Lutz.

Event	Description
Collection and an Introduction to LEZs 13th – 15th July 2021	**Day 1** gave the cities of León and Bhubaneswar the chance to present their project prototypes that they had been working on since the previous event; both chose to work towards implementing a LEZ in their cities. There was then a speed mentoring session with the consultants providing support. **Day 2** began with a presentation from Ricardo on project governance and decision making, highlighting the Bristol CAZ as an example of a complex but successful governance structure. The participants then mapped out the challenges and opportunities ('leverage points') of their projects. **Day 3** included an introduction to LEZs presented by Guy Hitchcock, which covered regulatory approaches, defining the scope of the LEZ and enforcement. This was followed by a detailed case study of Berlin's LEZ, presented by Martin Lutz. These were followed by a discussion laying out potential project data requirements, such as traffic, air quality or economic data. Participants were divided into groups to map the data needed for their projects, the results from which can be found in Appendix A1.
Community of Practice Event 3: LEZ Guidance and MER 7th – 9th August 2021	The final event gave participants the chance to present progress of their projects and covered the topics of Clean Air Zone guidance, indicators, and community engagement. **Day 1** began with videos from the 'visit my city' challenge, followed by updates from León and Bhubaneswar as to the progress made with their LEZ preparations. The key information from the CAZ Guidance Document was presented by Ricardo. **Day 2** focused on measuring impacts. Ricardo presented a guide to why indicators are needed, various types of indicators, criteria for what makes a good indicator and a summary of data collection. Participants then split into groups to run through an example by designing indicators for their projects. The results from this exercise can be found in Appendix A1. **Day 3** included a presentation on civil engagement and another 'Fishbowl' activity with three new experts, where inspiring examples of urban environmental projects with strong components of civil engagement were discussed. Participants were asked to consider the question "What do you want Breathable Cities to be from now on?" and the next steps for the continuation of the Community of Practice were set out.

The technical webinars and the Community of Practice events were attended by representatives from India on behalf of the Odisha State Pollution Control Board (OSPCB), as well as the Ministry of Environment in Delhi and professionals from Bhubaneswar and Cuttack including scientists, environmental engineers, the Member Secretary, Chief Environmental Engineer, and Assistant Executive Engineer for Bhubaneswar. The webinars and events were also attended by representatives from Mexico, including the Head of ProAire and climate change, the General coordinator of pollution and environmental health, Head of Regulation of Fixed Sources, PRTR (Pollutant Release and Transfer Registries) and Inventories, Director General of the Environment, Air Quality Chief of the Environmental Department for León, General Director of Air Quality for Department of the Ministry of the Environment and Territorial Planning for Guanajuato, Deputy Director of Air Quality of Ministry of Environment and

Natural Resources (SEMARNAT) Department for Mexico City, and the Secretary of the Environment and Territorial Planning for Guanajuato.

2.5.1 Learning pills

In order to enable the effective sharing of knowledge through the Community of Practice, several short informational videos known as 'learning pills' have been produced by Hevas, using content and materials produced by Ricardo. The topics summarised in the learning pills follow the topics covered in the International Best Practice Report, including;

- Air quality monitoring and data
- Communications and engagement
- Direct emission control
- Low Emission Zones
- New Technology

The videos provide a concise synopsis of information from the International Best Practice Report in a more accessible format. This allows participants to review information regarding a specific topic of interest quickly and easily. The five videos are available on the Breathable Cities platform.

2.5.2 Breathable Cities Learning Platform

The Breathable Cities platform (*breathablecities.live*) has been developed as a hub to share knowledge and communicate with colleagues from around the world regarding air quality challenges and solutions. The online platform is similar in layout to other types of social media, allowing members to post content, comment and communicate with each other. So far, the platform has been used to share invitations to events, relevant news articles and content from the Community of Practice such as the 'Visit my city' video challenge and the CAZ Guidance Document. This means that a body of air quality related content is available for participants to access when they need it. The platform also provides the opportunity to grow a social network of air quality professionals who can share their work and ideas, communicating easily.

How has the Community of Practice contributed to the success of the Triangular Cooperation?

The Community of Practice provided an opportunity to:

- Share ideas and experiences with other air quality professionals.
- Hear from leading experts in the air quality field.
- Receive specific technical advice and recommendations relating to ongoing air quality actions.

The Community of Practice lives on in the 'Breathable Cities' online platform which provides the participants with a space to stay in touch, share relevant articles, discuss the progress of their projects, access 'Learning Pill' educational videos, and continue to receive advice from the technical experts involved in the project.

3 Recommendations for future opportunities for air quality improvement

The Triangular Cooperation has provided the project team with insights into the strengths, skills and potential weaknesses of the approaches of the partner cities to air quality management. The project has also provided a platform on which the cities were able to openly share ideas, ambitions and challenges relating to the implementation of air quality actions. This offers a unique opportunity to make targeted recommendations for improving both the structures and systems which support air quality management, and the specific policies and technologies that may be suited to the cities needs and offer the greatest chance of improving air quality.

The following sets out:

- Recommendations for strengthening the CAAPs in both the Indian and Mexican cities;
- Recommendations for technological solutions to support improvements in pollutant emissions from transport sources in the Indian cities; and
- A suggested roadmap to support the development and implementation of the Bhubaneswar LEZ.

3.1 Strengthening CAAPs

Following the reviews of each city's CAAP, we have provided a set of prioritised recommendations for strengthening the CAAPs, as well as for broader air quality improvements. As the key technical assistance issues for each city are similar, many of these recommendations overlap, especially between Cuttack and Bhubaneswar, and between León and Salamanca, Celaya and Irapuato. Therefore, in this section we have provided a summary of the recommendations for the Indian cities and the Mexican cities, grouped, although the priority of these actions is slightly different for each city.

Cuttack and Bhubaneswar

- ***Completion of a source apportionment study.***
    - This has been described in both CAPs as a medium-term action (within one year); for Bhubaneswar the OSPCB is listed as the responsible authority but none has been identified for Cuttack. This action should be the top priority for both cities as the information obtained from a source apportionment study would better inform the rest of the plan and assist in prioritisation of the long list of air quality actions.

- ***Increasing the air quality monitoring capacity.***
    - This is the second priority for both cities. Both CAPs set this as a short-term priority action (within six months) for which the OSPCB is responsible, with support from the Central Pollution Control Board (CPCB). The action requires two (Cuttack) or three (Bhubaneswar) real-time monitoring stations to be set up within six months, and the remainder within one year. However, since the plan's publication in 2018, the capacity for air quality monitoring has not been increased in either city.
    - As has been identified in the CAAP, manual monitoring stations have limitations when it comes to assessing against air quality standards, implementing Graded Response Action Plans (GRAPs), and pollution forecasting. Continuous monitoring stations would be more beneficial for the city by providing higher quality data. It is also important that any new monitoring stations are sited carefully to ensure they are representative of human exposure, as well as taking into account the emissions of key polluting sources.
    - The current and proposed monitoring stations could be supported by a network of low-cost sensors. These types of monitors could be useful for the proposed rural and peri-urban air quality monitoring suggested in the CAAPs. Although the opinion of low-cost

monitors in India is mixed, they would be extremely useful in identifying key pollution hotspots in both cities.

- ***Inclusion of a detailed plan for implementation of each action.***
    - The current CAAPs provide a good basis for a detailed plan for each air quality action. The tabular format allows for additional rows/columns to be added to include:
        - Sub-actions for each action
        - The responsible agency/agencies for each sub-action identified, including clear identification of the need for collaboration
        - The technical and practical feasibility of the measure
        - Clearer timelines in terms of start/end dates, and targets for each sub-action
        - Estimated cost of sub-actions, maintenance, and overall cost of each measure
        - Funding sources (secured, and provisional) for each sub-action, maintenance, and overall cost of the measure
        - The metric/metrics that will be used to monitor the implementation and success of each action (e.g. increase in public transport usage, decrease in emissions, decrease in pollutant concentrations)
        - The expected impact on the above metrics, focusing particularly on emissions and pollutant concentrations if possible
- ***Undertaking air quality modelling to assess the impact of proposed air quality actions.***
    - The CAPs for both cities contain a very high number of measures, most with a priority assigned. It would be very ambitious to implement all of the measures, and especially in the timeframes that have been indicated. The evidence seen during this project, for example the lack of progress in installing new air quality monitoring stations, suggests that prioritising a smaller number of measures with better evidence to show their potential impacts would enable funding to be secured and action to be taken. Examples of air quality models used in India are provided in the full report for each city.
    - Considering transport-related emissions, both CAPs provide a significant number of actions for the relevant sectors: many under ‘vehicular emissions’, some under ‘public transport system’ and a few under ‘road dust’. It is unclear how the actions have been prioritised – the timeline for implementation does not always align with the priority, and many have little to no description of what the action entails. One of the best ways to prioritise the actions, and provide evidence for this (which is likely to help get funding), is to assess the potential air quality benefit of implementing each action.
- ***Undertaking some form of impact assessment to capture the wider economic, social, environmental and political impacts of the proposed air quality actions.***
    - The ideal case would be to undertake modelling to estimate the potential scale of impacts on the above themes. If modelling is not feasible, it would be useful to list the potential wider economic, social, political and environmental impacts of the proposed actions. This could be achieved by consulting with the relevant departments to identify possible impacts and determine their likelihood (low, medium or high) as well as the severity of the impacts (again low, medium or high). The CAPs are well set up to incorporate this within the table of actions.
- ***Creation of a central air quality communications strategy.***
    - To begin with, this central communications strategy should focus on collating all the current air quality communications sources into one area. Once this has been achieved, the focus should shift to aligning the communications, before expanding the

capacity to include additional information such as pollution forecasting, more monitoring data, and details of air quality projects in the cities.

- ***Development of capacity for pollution forecasting.***
    - If the air quality monitoring and modelling capacities for the cities can be increased, a logical way to link and make the most use of these whilst informing the public is to develop capacity for air pollution forecasting. The forecast could be linked into the central communications strategy and might take the form of a map of the air quality index (AQI) and/or estimated AQI at monitoring locations in the city.

León Metropolitan Area, Salamanca, Celaya and Irapuato

- ***Undertaking some form of air quality modelling to assess the impact of proposed air quality actions.***
    - This is the top priority action for both CAAPs, as both contain nearly measures in total. It would be very ambitious to implement all of the measures, and the timeframes that have been indicated are quite vague. There appears to be no prioritisation of measure implementation in the plan. In a stakeholder engagement meeting it was raised that there is a need to focus actions on areas of high priority, which suggests that prioritising a smaller number of measures with better evidence to show their potential impacts would enable action to be taken.
    - One of the best ways to prioritise the actions, and provide evidence for this, is to assess the potential air quality benefit of implementing each action. Some examples of air quality models used in Mexico include: the Weather Research and Forecasting (WRF) model, Land use Regression (LUR) models, Multiscale Climate Chemistry Model (MCCM), Random Particle Transport and Diffusion Model (RAPTAD) and the California Institute of Technology (CIT) 3D Airshed Model.
- ***Set out clear prioritisation of the air quality actions in the CAAPs, based on the supporting information already available in the plan, and any further modelling undertaken.***
    - Prioritisation should take into account the following considerations:
        - Which pollutants will be impacted by the measure;
        - The magnitude of the measure's potential impact on air pollution;
        - The geographical scope of the measure;
        - The timeline for implementation;
        - Whether or not funding is readily available to implement the measure;
        - The current technical capacity of the authority / authorities identified as being responsible for the measure's implementation; and
        - Whether other actions need to be implemented before the measure can begin.
    - To clearly show the prioritisation of measures, they could be summarised in a table at the end of the section describing the measures, which currently set out actions under eight strategies. It is also unclear whether or not the strategies have been prioritised – if not, then this could also be incorporated.
- ***Strengthening of the air quality actions proposed under the 'Sustainable Mobility' strategy.***
    - Both CAAPs mention repeatedly that mobile sources, i.e. transport, are responsible for a significant proportion of air pollutant emissions in the cities. However, the 'Sustainable Mobility' strategy contains only a few measures, out of a total of nearly 40 in each plan.

  - There are significant gaps in the transport-related measures in both ProAires. In particular, it has been raised that planning (e.g. for shopping centres and other facilities) does not take into account the needs of non-motorised transport such as cycling and walking. It was also raised that the current cycling infrastructure is inadequate in terms of safety and climate challenges. However, there are no measures in the current ProAire that target active travel as a means to replace the private vehicle. Another aspect of mobility that lacks actions is public transport. A specific plan as to which types of public transport will be targeted and how they will be modernised should be set out in the plan.

- ***Strengthening of the air quality actions proposed under the 'Reduction and Control of Emissions in Specific Sources' strategy.***
  - Of all eight strategies in the ProAires, only two provide technical measures: 'Reduction and Control of Emissions in Specific Sources' and 'Sustainable Mobility'. The remaining strategies focus on environmental policies, sustainable management of future resources, public education and communication, research, and generating additional funding for future measures. These types of actions typically take a long time to implement, are less visible to the public, and may not have a measurable impact on air pollutant concentrations. Therefore, the CAAPs could include more direct emission control type measures.
  - The 'Reduction and Control of Emissions in Specific Sources' strategy contains approximately ten measures in each plan (out of nearly 40 in total) that target brick kilns, open burning, transport, industry and point sources. This is not an adequate number of measures to target such a range of emissions sectors, even though there are some sub-actions within each measure. To sufficiently address these sources of pollution, this strategy should be expanded in each CAAP.

- ***Inclusion of a detailed plan for implementation of each action.***
  - The current ProAires provide a good basis for a detailed plan for each air quality action, as they already contain sub-actions for each measure, as well as an approximate timeline for each sub-action and the relevant authority/authorities responsible for implementation. The plans would benefit from a summary table of the prioritised measures – a tabular format would allow for rows/columns to be added to include:
    - The clear identification of the need for collaboration between the responsible agency/agencies for each sub-action
    - The technical and practical feasibility of the measure
    - Clearer timelines in terms of start and end dates (in months or weeks, rather than only years), including targets for each sub-action
    - Estimated cost of each sub-action, maintenance, and overall cost of the measure
    - Funding sources (secured, and provisional) for each sub-action, maintenance, and overall cost of the measure
    - The metric/metrics that will be used to monitor the success of each action (e.g. increase in public transport usage, decrease in emissions, decrease in pollutant concentrations)
    - The expected impact on the above metrics, focusing particularly on emissions and pollutant concentrations if possible

- ***Undertaking some form of impact assessment to capture the wider economic, social, environmental and political impacts of the proposed air quality actions.***
  - The ideal case would be to undertake modelling to estimate the potential scale of impacts on these themes. If modelling is not feasible, it would be useful to list the

potential wider economic, social, political and environmental impacts of the proposed actions. This could be achieved by consulting with the relevant departments to identify possible impacts and determine their likelihood (low, medium or high) as well as the severity of the impacts (again low, medium or high). Again, this could be included in a tabular summary of the prioritised actions.

3.2 Technical solutions

The International Best Practice Report (Section 2.1) set out a comprehensive list of examples of best practice for managing emissions from transport and achieving improvements in air quality. The findings from the review (including a Multi-Criteria Analysis (MCA) type evaluation – see Appendix A2), along with interviews with partners in the UK and Germany, as well as the webinars and Community of Practice events held throughout the Triangular Cooperation Project, have enabled us to identify key success factors for effective interventions, and measures that may be recommended for implementation. Experiences and expertise have been shared throughout the Triangular Cooperation, meaning these recommendations are tailored to reflect the specific needs and capabilities of the cities.

The sections below outline specific recommendations for technical solutions to reduce emissions from transport, to be implemented in Cuttack and Bhubaneswar over the short-, medium-, and long-term. They are not an exhaustive list of actions, but rather the measures we believe will be the most effective for each city, based on what we know about the challenges and ongoing activities there. Throughout the recommendations, the interest in implementing a LEZ or CAZ in Bhubaneswar has also been taken into account, so many of the recommendations for Bhubaneswar have been chosen to help contribute to the successful implementation of a LEZ / CAZ.

3.2.1 Short-term technical solutions

Short-term technical solutions should be the priority actions for the cities. They are actions that can be implemented on a short timescale (i.e. one to two years). This means that the cities hopefully already have the capacity to be able to implement these actions. To enable them to be implemented quickly, actions have been chosen that are relatively cheap (or for which funding is already available), that are within the technical capabilities of the teams in the cities, and that won't require huge changes to implement.

Cuttack and Bhubaneswar

Although the cities of Cuttack and Bhubaneswar have significant differences in the air quality actions they are able to implement, in the short-term we believe their priorities should be the same. The short-term recommendations are largely those made in Section 3.1 as part of the review of the cities' CAAPs, as these can be done on a short timescale and will strengthen the CAAPs in preparation to implement more ambitious measures in the future.

Expansion of the air quality monitoring network. Both cities' CAAPs identified that the current number of air quality monitoring stations are not adequate for the size and population of the cities. In addition, only manual monitoring is available, which has severe limitations in terms of data quality. The recommendation is to install additional manual monitoring stations (as is already identified in both cities' CAP) to bring the number up to the target amount; at least one continuous monitoring station should also be installed. In Bhubaneswar in particular, it may be useful to install low-cost sensors in a targeted area, for example the Ekamra Kshetra Heritage area.

Capacity for air quality forecasting / display of the current air quality. If the air quality monitoring networks in the cities are expanded, and especially with installation of at least one continuous monitoring station in each city, the next step would be to use this information along with modelling to generate capacity for air quality forecasting. In particular, making use of both cities' monitoring networks and having a joint forecasting website (which can expand as the monitoring networks continue to improve) would be beneficial. The use of continuous monitoring and even low-cost sensors could allow for the current air quality to be displayed online and/or somewhere in the cities, so that the general public gain interest. Examples of air quality forecasting and displays of air quality to the public, from Oxford, have been presented at the CoP and can also be found in the International Best Practice Report.

Completion of a source apportionment study. Neither city has source apportionment information, although there is an emissions inventory for Bhubaneswar. Both cities would benefit from the information gained from source apportionment, especially if the contribution from different vehicle types can be calculated. This would allow for better prioritisation and targeting of air quality measures in the cities in the long-term.

City-wide mobility campaign. The beginnings of a city-wide mobility campaign would be beneficial for both cities, in order to get residents aware and used to the idea that mobility in their cities is going to change over the coming years. This campaign should be promotional and educational, first focusing on collecting information about the current status of mobility, before moving on to identify and explain the upcoming measures to reduce emissions from transport.

3.2.2 Medium-term technical solutions

Medium-term technical solutions are actions that the cities should begin planning for, but may take more than one-to-two years to implement. These measures are more ambitious than the short-term actions, but are also likely to have a greater impact on air quality. The actions are likely to require greater levels of funding, but some of this may already be available or funding streams identified. The relevant teams in the cities may have some or all of the technical capacity to implement the actions, but some training might be required.

Cuttack

Improvements to the footpath network. Cuttack is described in its CAAP as a compact city, and is smaller than Bhubaneswar. The public transport system is not well-established, therefore, most of the medium-term measures should focus on strengthening the active travel network. It was noted in the CAAPs that pedestrians are exposed to high risks of accidents and poor air quality as they share the same right of way as motorised vehicles; a separate, high-quality footpath network in Cuttack would encourage mode shift from the private vehicle to active travel. The requirements for an ideal footpath network are set out in the International Best Practice Report.

Bike rental scheme(s). Bike rental schemes encourage the population who might not be able to afford to purchase a bicycle to take a more active form of transport. Bhubaneswar already has the MoCycle bike sharing / rental scheme, which should be expanded to Cuttack (or a similar one implemented). A benefit of this is that lessons learnt from the scheme in Bhubaneswar can be applied to the scheme in Cuttack.

Priority bicycle routes / junctions. It has been raised during stakeholder engagement that the roads in Cuttack are not wide enough to allow for bicycle lanes adjacent to the motorised traffic. It may be more appropriate for the city to implement certain priority routes for bicycles, supporting the bike rental scheme. This is particularly prudent at junctions, where cyclists are likely to have the most interaction with motor vehicles. Showing prioritisation to cyclists can encourage more people to take up cycling and build a real community, as was demonstrated in Berlin (see the International Best Practice Report for details).

Improvement of public transport infrastructure and service quality, including mapping passenger needs. As mentioned above, the public transport system in Cuttack is not well-established. In the medium-term, progress should be made to improve this, so that further improvements can be made in the long-term. The first step should be to map passenger needs, via surveys or other methods. The current state of the public transport and the weaknesses in particular should be assessed, to determine where the first improvements need to be made. This action is likely to apply in the medium- as well as the long-term.

Bhubaneswar

Discounted / intermodal tariff offers and networking in public transport. Public transport in Bhubaneswar should be improved in support of the LEZ that it hopes to implement. The public transport system in Bhubaneswar is more well-established than in Cuttack, however, the usage is still not that high (5.6% according to the CAAP). To increase public transport usage, discounts and intermodal tariff offers should be considered such as: including as many modes of transport as possible under one ticketing and tariff system; digital sales options (e-ticketing); and reasonable pricing / discounts for daily,

weekly, monthly, or even annual tickets. Note that there may be difficulties in implementing this if multiple companies run different modes of public transport; agreements on ticketing and pricing may be more difficult.

Website for any rules / regulations relating to air quality. This measure is also supporting the implementation of a LEZ in Bhubaneswar. If rules and regulations regarding air quality are to be set for the city, and especially if bans or fines are involved, then it is important that these are set out clearly somewhere where the general public can find them. The public can then be as informed as possible, and avoid any breaches of the rules. A great example of this is the Oxford Zero Emission Zone (ZEZ), for which more information can be found in the International Best Practice Report.

Parking controls. The desire to restrict parking for private vehicles in Bhubaneswar has been raised repeatedly during stakeholder engagement, and again would support the implementation of the LEZ. A balance must be struck between discouraging the use of private vehicles and still enabling accessibility for them. As well as discouraging car use, it is important to make other modes of transport more attractive so that there are multiple reasons for changing to another form of transport. Converting private car parking spaces to bicycle parking spaces or (if appropriate) footpaths / cycle paths / green spaces can help to encourage people to travel by bicycle or on foot.

'Car-Free Day' and other events used for promotion. Promotional events will be very important leading up to the launch of the Bhubaneswar LEZ, and in particular, regular 'Car-Free Days' should be set up. These events will allow residents to get used to the idea that they will not be able to drive into the LEZ area, providing a sort of 'soft launch'. Such a measure is also likely to identify issues that may arise when the LEZ is formally implemented, which means these issues can be mitigated in advance. In addition, positive, promotional events will help people realise the benefits and become engaged with the LEZ process.

3.2.3 Long-term technical solutions

Long-term technical solutions are the future goals for the cities in terms of what they'd like to implement. These actions may be already present in the examples of international best practice, but not yet feasible for the Indian cities as the infrastructure is not yet there. These technical solutions are likely to be the most expensive and funding is likely not identified yet. Training or recruitment may also be required within the city teams in order to implement such solutions, and it is very likely that multiple teams in the city will need to work together to deliver the projects. The timescales for these actions may vary, but could require more than five years to implement.

Cuttack

Municipal mobility management. Although the implementation of comprehensive electric vehicle charging infrastructure in Cuttack may seem a distant goal, some EV infrastructure should be installed if possible. Upgrading the municipal fleet to EVs or similar is a great way of demonstrating best practice and leading by example, making use of any infrastructure that is in place. Municipal mobility management does not only have to include upgrading vehicles to EVs, it may also include staff travel strategies to minimise private vehicle usage, working from home policies, or other ways to lead the city by example.

Discounted / intermodal tariff offers and networking in public transport. As has already been mentioned, the public transport system in Cuttack is not as well-established as that of Bhubaneswar. Where Bhubaneswar may be able to implement discounts and intermodal tariff offers in the medium-term (see the section above), it may be more appropriate for Cuttack to aim to do this on a longer term once the public transport system has matured. This would also provide the opportunity to learn from Bhubaneswar's experiences.

Traffic flow smoothing. Narrow, historical roads and little space to expand or modify the road network in Cuttack lead to congestion, but few options to relieve it. Traffic smoothing comprises a wide variety of measures that aim to reduce start-stop traffic, reduce congestion, and reduce emissions from road transport. Just some of the actions that may be appropriate for Cuttack include effective road space management (amending the road layout, cycle lanes and bus lanes), removal of on-street parking,

reconsidering delivery / loading arrangements, and reviews of traffic light signal timings. More information on these actions can be found in the International Best Practice Report.

Bhubaneswar

Comprehensive electric charging infrastructure including e-charging hubs. Bhubaneswar should follow the example of cities like Hamburg and aim to implement a comprehensive EV charging infrastructure in the long term. Power supply and connection to the grid, a network of charging facilities (for the public, residents, and workplaces), funding and grants to purchase EVs, and preferential parking policies, are all vital and hopefully will result in a change in the fleet composition via a greater uptake of EVs.

Low-emission bus fleets including retrofitting and/or electric buses. With improvements to Bhubaneswar's public transport system in the mid-term, and the implementation of the LEZ in the long-term, it is appropriate to upgrade the bus fleet to retrofitted, hybrid or EV buses. With more people travelling on the public transport network and its potential expansion, it's even more important that bus fleets are as clean as possible, because they will travel significantly greater distances daily than private vehicles. This is an expensive investment, and is likely to happen over a long period of time.

Dynamic traffic management. Traffic flow smoothing has been recommended for Cuttack in the long term. For Bhubaneswar there may be scope to incorporate a dynamic traffic management system – especially as it is a larger city. The overall aim of dynamic traffic management is the same – to achieve a smooth flow of traffic – but also gives the ability to react to events such as pollution hotspots, congestion, or accidents. Berlin's state-of-the-art traffic control centre (Verkehrsregelungszentrale, VKRZ) is the "gold standard" of dynamic traffic management, but Reutlingen (also in Germany) also has a traffic computer with a software system for adaptive control of traffic networks, that may be a more appropriate example to follow for a city the size of Bhubaneswar. Both can be read about in the International Best Practice Report.

Preparation of a LEZ in Bhubaneswar

Throughout the Triangular Cooperation the project team provided support and guidance to the partner cities in the development of air quality actions. For two cities, Leon and Bhubaneswar, this focused on the development of a LEZ. The project team provided technical support, through the CAZ Guidance Document, Community of Practice events and technical webinars, to aid the cities development of the LEZs, and discussed the preparation of an Implementation Roadmap for Bhubaneswar.

The roadmap for developing the Bhubaneswar LEZ was prepared in line with the Clean Air Zone Guidance Document. It lays out tasks and potential next steps for project development and implementation for the LEZ and has been updated based on the discussions during the webinar.

The following summarises the recommended Roadmap for the Bhubaneswar LEZ.

Table 6: Proposed roadmap for implementation of the Bhubaneswar LEZ

Phase	Task	Current status	Potential next steps
Project development	Define the scope of the CAZ / LEZ	Proposed elements of the LEZ outlined	Bhubaneswar have set out an indicative boundary for the LEZ, which covers the Ekamra Kshetra Heritage Zone. As this is a large area, it is recommended the city consider phasing the LEZ, with an initial focus on key pollution hotspots, before expanding out to wider areas. Consideration must also be given to the restrictions to be applied, and how these may differ between vehicle types and users of the zone (i.e. local residents, businesses, tourists). Penalties could be applied based on the type of vehicle (e.g., resident, public transport, or utility vehicles), the emissions standard of vehicles and fuel types (e.g. Euro standard and petrol vs EV), or finally the frequency with which a vehicle enters the zone (e.g. daily commuters vs irregular visitors). **See Chapter 3 of CAZ Guidance Document.**

Phase	Task	Current status	Potential next steps
	Data collection	Air quality data collected at local station Data collection matrix completed following CoP2	The city must develop a data collection plan to support the LEZ. It is understood there are plans to install one continuous monitoring station within the zone – the location of this monitor will be critical to understanding the impacts of the policy, therefore it must be selected to ensure the best characterisation of air quality across the zone. The city may wish to supplement the continuous monitoring station with the use of low-cost sensors. These would also support wider communication measures and assist with public engagement (i.e. through the use of mobile apps). The city should stablish a baseline for air quality, in order to accurately understand the current levels of air pollution, including the location of local hotspots and key sources. Once established, this can be used to set targets for the improvement of air quality. Consideration should also be given to the potential impacts of the measures implemented in support of the LEZ and how these can be tracked through the collection of indicator data. **See Chapter 4 of CAZ Guidance Document.**
	Air quality analysis	Local monitoring data available	Bhubaneswar should conduct an air quality assessment to determine the projected impact of the proposed changes on air quality. It is important this is underpinned by accurate traffic data and forecasts, and considers the potential for knock-on effects for local communities as a result of diverted traffic. The zone should also not be considered in isolation, but as part of the wider community. **See Chapter 4 of CAZ Guidance Document.**
	Economic assessment	Not yet complete	Bhubaneswar should undertake a cost-benefit analysis of the proposed measures. Key considerations should include: - The costs associated with the implementation and enforcement of the green sticker programme and monitoring of vehicles / generator sets. Whether these activities will generate a revenue stream, how this will change over time and how the income will be used to support other areas of the LEZ. - The implications for the implementation of the green sticker programme on local businesses and organisations. Will the costs of upgrading vehicles / paying fines be offset by other measures? - The expected uptake of EVs and required investment in charging infrastructure. - The costs associated with improvements to the network to enable an uninterrupted electricity supply. - The infrastructure investment required to support walking and cycling. Incentive schemes to encourage the uptake of cycle. The operational costs of maintaining any cycling schemes. - How the costs of the LEZ will be met and internal / external funding sources. **See Chapter 4 of CAZ Guidance Document.**
	Social / health impacts	Not yet complete	Bhubaneswar should undertake an assessment of societal and environmental impacts associated with the LEZ. This is likely to be accompanied by consultation with the local community, businesses etc. **See Chapter 4 of CAZ Guidance Document.**

Phase	Task	Current status	Potential next steps
	Consultation	Not yet complete	Conduct stakeholder consultation, including national / state government, private sector, academia, local businesses / community groups. **See Chapter 5 of CAZ Guidance Document.**
Project implementation	Governance	Proposed elements of the LEZ outlined	It is recommended Bhubaneswar agree a governance framework to oversee the delivery of the LEZ. This may include the establishment of a Steering Committee that could feed into the Project Advisory Committee for the EKAMRA Plan. This framework should set clear roles and responsibilities and seek political backing to support implementation. **See Chapter 6 of CAZ Guidance Document.**
	Monitoring, Evaluation & Reporting	Started at CoP2	Bhubaneswar should establish a system for Monitoring, Evaluation and Reporting, to track the performance of the proposed actions under the LEZ, with the aim of achieving ongoing improvements. It is recommended the city use the data collection matrix, presented at CoP2, as the basis for a MER framework. **See Chapter 6 of CAZ Guidance Document.**

4 Systemisation of success

4.1 Participant feedback

Feedback was received from participants of the Triangular Cooperation, collected via an online survey and during two interviews held with colleagues from the Mexican and Indian cities on the 27th and 30th September 2021, respectively. The feedback covers all three work packages, and considers the air quality issues facing the cities, the actions being taken to respond to these challenges, how the Triangular Cooperation has supported these actions and opportunities for future support and collaborations leading to systematization of the successes documented throughout the project.

This review was undertaken to determine the extent to which the Triangular Cooperation has supported the partner cities in developing an effective strategy for improving the air quality impacts of urban transport. It has aimed to consider the current state of urban air quality in each city, the actions being taken to improve this, and how the Triangular Cooperation has facilitated this change. The outcomes of the review highlight certain themes in the respondents' feedback, including:

- **The opportunity to share ideas and experiences with other air quality professionals**

  Participants from both India and Mexico commented on their appreciation for the chance to meet with representatives of other cities and states, to discuss challenges and solutions relating to improvements in air quality. Specific comments related to the 'energy' created during the live events, and the opportunity to 'exchange experiences' on technical solutions to air quality problems. Expert platform design and facilitation by Hevas was important for generating energy, and the high standard of technical input from Ricardo and other experts was vital for effective exchange of experiences.

  Participants also appreciated the multifaceted approach to the Triangular Cooperation, which involved a combination of live and pre-recorded events, and access to the breathablecities.live platform. Although some feedback suggested 'in-person workshops would have been more effective', it was largely agreed that the virtual settings for the events enabled the bringing together of a wider range of city representatives, than would have been possible had it been an in-person event.

- **The opportunity to hear from leading experts in the air quality field**

  The Community of Practice Events allowed us to invite expert speakers from the field of air quality to share their insights on effective approaches to air quality management. Speakers included:

  - Martin Lutz, Head of Air Quality Management Unit, Berlin Senate Department for Environment, Transport and Climate Protection
  - Martin Kraftl, Air Quality Programme Manager, Oxford City Council
  - Patrick Wichern, Project Manager, hySolutions, Hamburg
  - Jochen Hake, Hamburg Ministry of Environment, Climate, Energy and Agriculture
  - Dr Guy Hitchcock, Technical Director for Low Emission Cities, Ricardo Energy & Environment

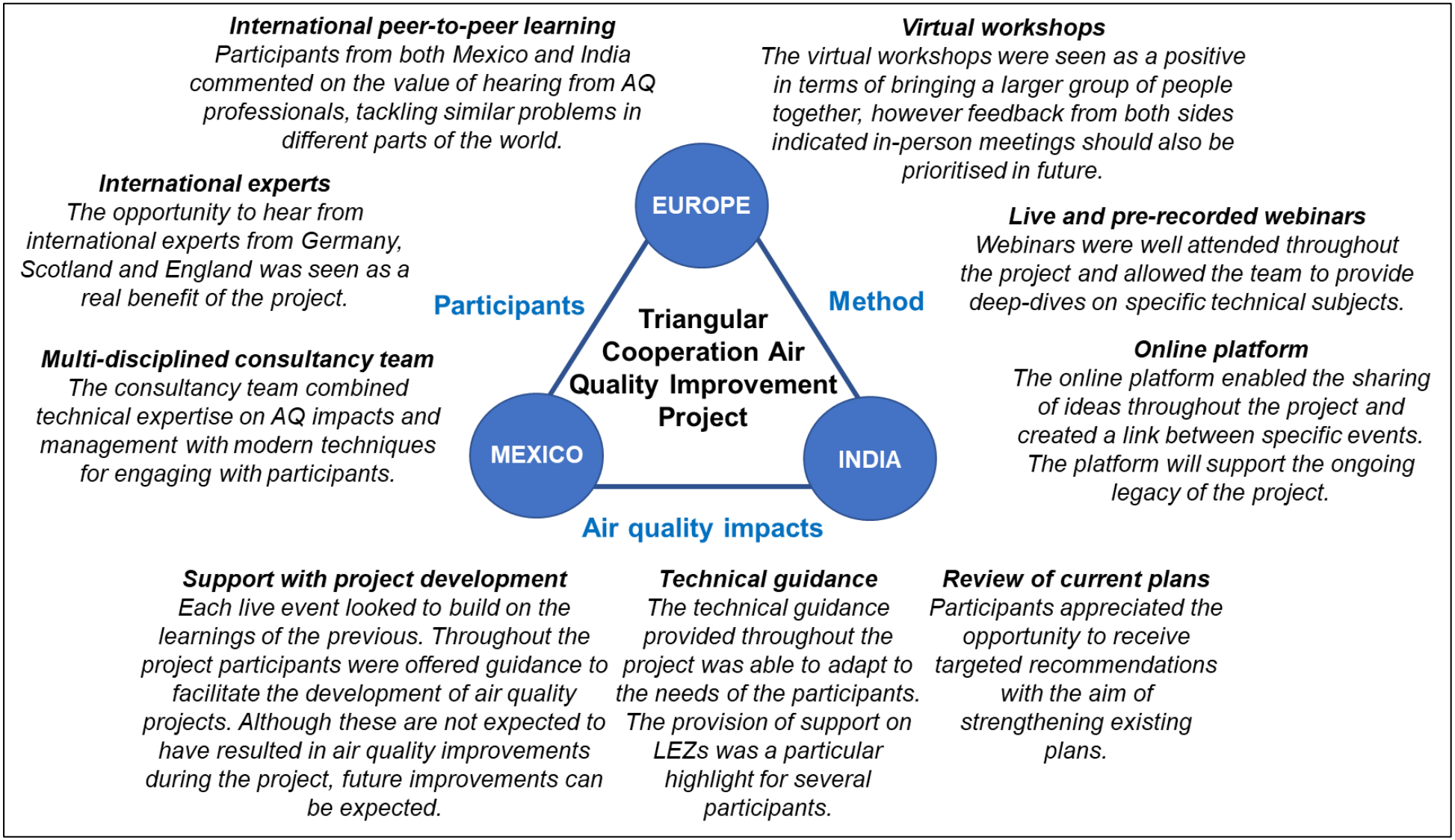
  Feedback from participants highlighted this aspect of the project as being especially beneficial. In particular, respondents commented on the value of hearing from speakers on issues relating to the implementation of LEZs, including approaches to get “better participation from all members of society” and some of the broader challenges that can be faced when implementing a LEZ.

- **The opportunity to the receive specific technical advice and recommendations relating to ongoing air quality actions**

  A key component of the Community of Practice, and broader support package provided under the Triangular Cooperation project, was the provision of technical capacity building to facilitate the development of effective actions to address air quality issues arising from urban transport. This support included talks, webinars and guidance documents on aspects relating to project development, including project planning, prioritization, data collection, governance systems and monitoring, evaluation and reporting. Feedback from participants in India and Mexico suggests this was highly valuable and has aided the cities in furthering their proposed air quality actions. In particular, the provision of support relating to the implementation and operation of LEZs was found to be welcomed by respondents from both India and Mexico, with comments indicating this facilitated the identification of “key actors in actions that are planned to be carried out”, and an improved understanding of “the benefits of projects and how to transmit them to policyholders / decision–makers”. These technical materials were presented during live events, allowing participants to ask questions and the consultants to offer targeted responses and recommendations. The project materials have also been available via the breathablecities.live platform, which will continue to be accessible to all participants following the completion of the project. The technical guidance on LEZs was used by Odisha in the development of the Concept Note for the Bhubaneswar LEZ, which subsequently received approval by the State Government.

The following diagram provides a summary of the feedback received through the survey and interviews relating to the participants, methods and air quality impacts of the project.

Figure 2: Summary of feedback on the Triangular Cooperation



Based on the feedback received during the survey and interview process, there is a high level of satisfaction with the content delivered during the Triangular Cooperation project. Participants in both India and Mexico have been able to identify key areas of concern regarding air quality in their cities, followed by an exchange of experiences, ideas and technical information about solutions to these problems. The international nature of this project has allowed for participants to relate to the issues faced in cities in other countries. This includes sharing of ideas between cities which are at a similar stage in their air quality planning process, as well as learning from cities at different stages.

The format of the events has helped to disseminate information, the engaging online discussions allowing for a sense of community to develop over time. The feedback showed a consensus in both India and Mexico that participants would prefer in-person interaction for this type of project. In-person events can be beneficial in terms of engagement and may be integrated into future projects. However, the online content used during the Triangular Cooperation, including live events, webinars and video 'information pills', have allowed for conversation between people who may not have otherwise had the opportunity.

The technical content provided during the Community of Practice has been tailored to the needs of the cities as the project progressed, with a focus on support for LEZ development and community engagement. The ability to adapt the workplan to the requirements of the cities has ensured the content offers participants the most value for their time and enabled them to consider key issues before undertaking project planning.

The Breathable Cities platform has further extended the benefits of these events and has been well-received by participants. The platform provides an opportunity to share technical information, ask about methods used in other cities and share insights with other air quality specialists. This site will remain active, allowing participants to share progress in their projects and continue to engage in the Community of Practice. It is hoped the breathablecities.live platform will enable the Community of Practice to continue and grow, with ongoing collaboration and discussion relating to the development of actions. This platform can also be used as an indicator of the areas in which the cities require further support.

The Triangular Cooperation project has aimed to support the partner cities with the development of effective actions to improve air quality in urban environments. The project has seen two cities; Bhubaneswar and Cuttack, make significant strides in designing and seeking support for the implementation of LEZs. However, as many of the most effective air quality actions require long lead times, it has not been possible to observe the full life cycle of these projects during the timeframe of the project, or to understand their impacts on emissions to air and ambient air quality. Although, the *breathablecities.live* platform will allow partner cities to share ideas and experiences regarding the implementation of these projects, it is likely further technical support will be needed during the different project development stages, including project conception, development, funding, implementation and monitoring & evaluation. It is recommended consideration be given to how the Triangular Cooperation could be expanded to incorporate these stages, not just for the proposed LEZs, but for all priority air quality actions planned for implementation in the partner cities.

4.2 Future systemisation

In order for air quality improvement to continue towards becoming an integral part of the city planning and management systems, the following steps are recommended:

- Promoting the breathablecities.live resource to a wider range of stakeholders in each city
- Making the materials shared through breathablecities.live more widely accessible – e.g. through social media, with links to breathablecities.live for those interested in finding out more
- Continuing to facilitate events through the breathablecities.live. This could be events with presentations/training on key topics, or more straightforward opportunities for participants to share experiences and solutions
- Develop new materials to share the success of initiatives such as the Bhubaneshwar LEZ
- Ensure that participants in this program are actively seeking to integrate air quality considerations into city development plans – for example, highlighting the health and economic

benefits of improving air quality to ensure that air quality improvements move up the list of priorities for future investment.

- Provide further support to the Indian cities to enable the concepts of action prioritisation and project development to be incorporated into the State-level air quality micro planning requirements.
- Support León and Bhubaneswar with detailed implementation planning for the proposed LEZs, including assessment of air quality and economic impacts.
- Consider opportunities to expand the Community of Practice to include AQ professionals from other cities in India, Mexico and beyond.

A1 Appendix 1 – Activities from webinars and workshops

Figure A. 1: Summary of content of the Breathable Cities Community of Practice

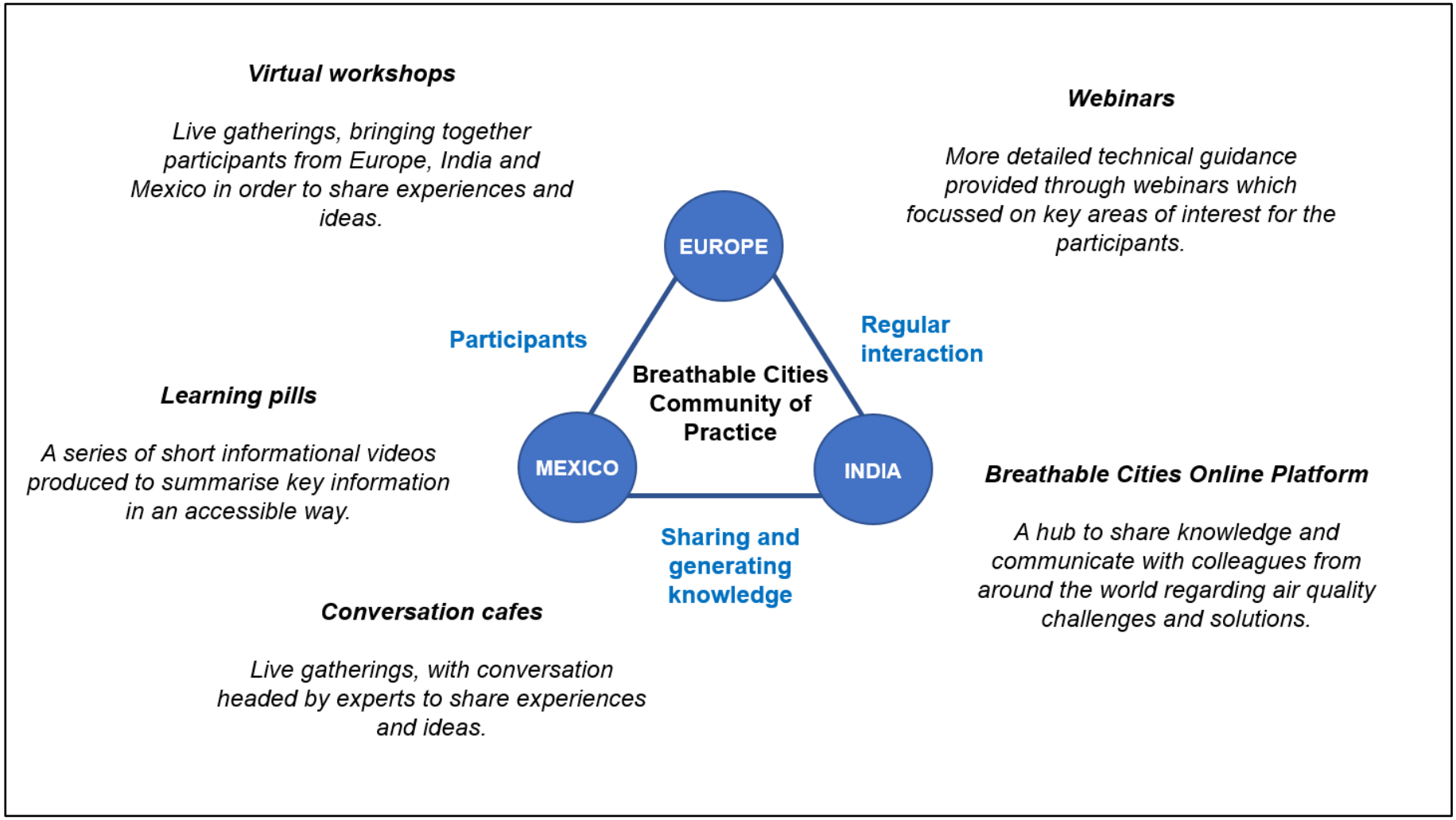


Figure A. 2: Screenshot of participants from Day 1 of the Community of Practice

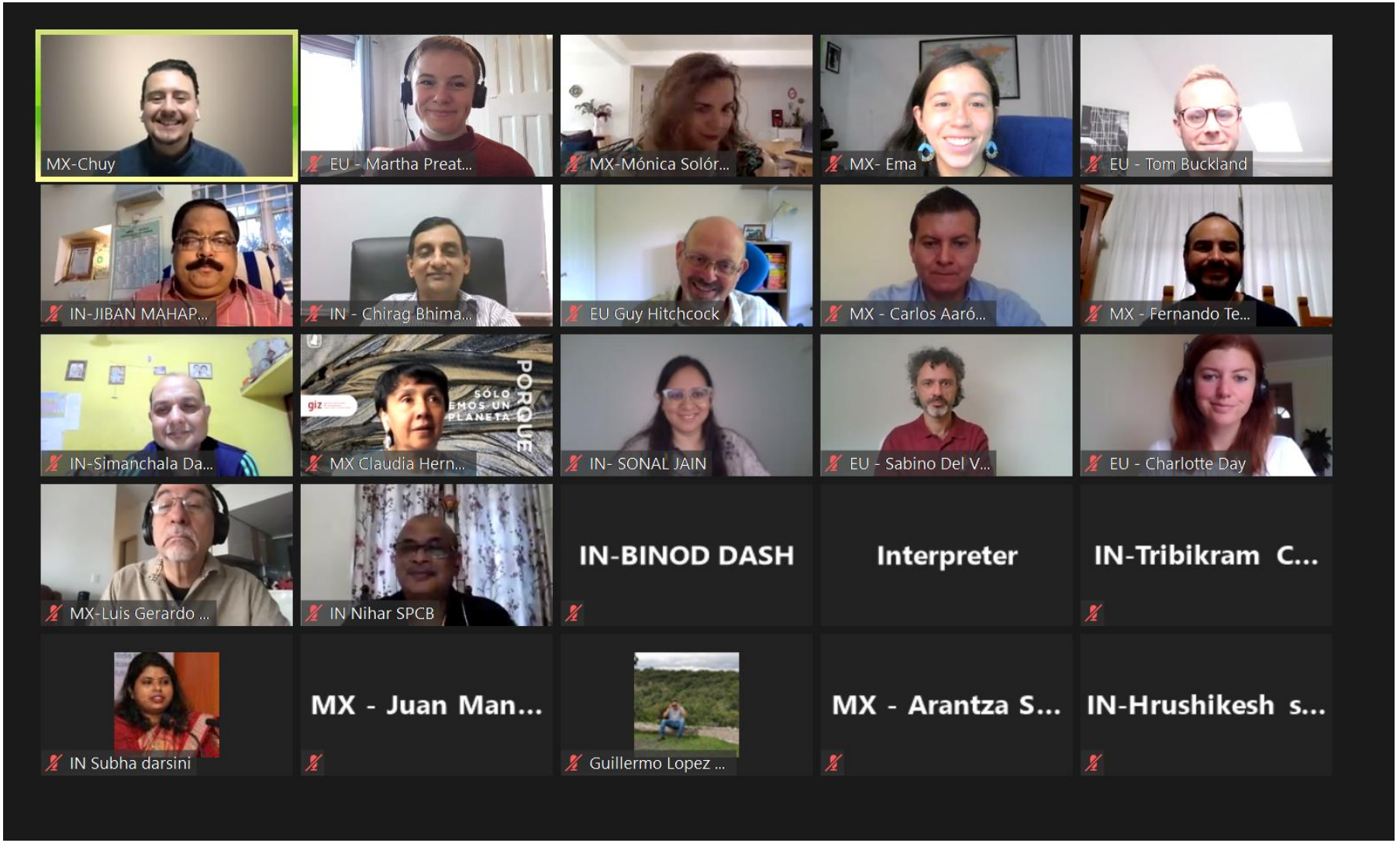


Figure A. 3: Screenshot of participants in the second CoP event

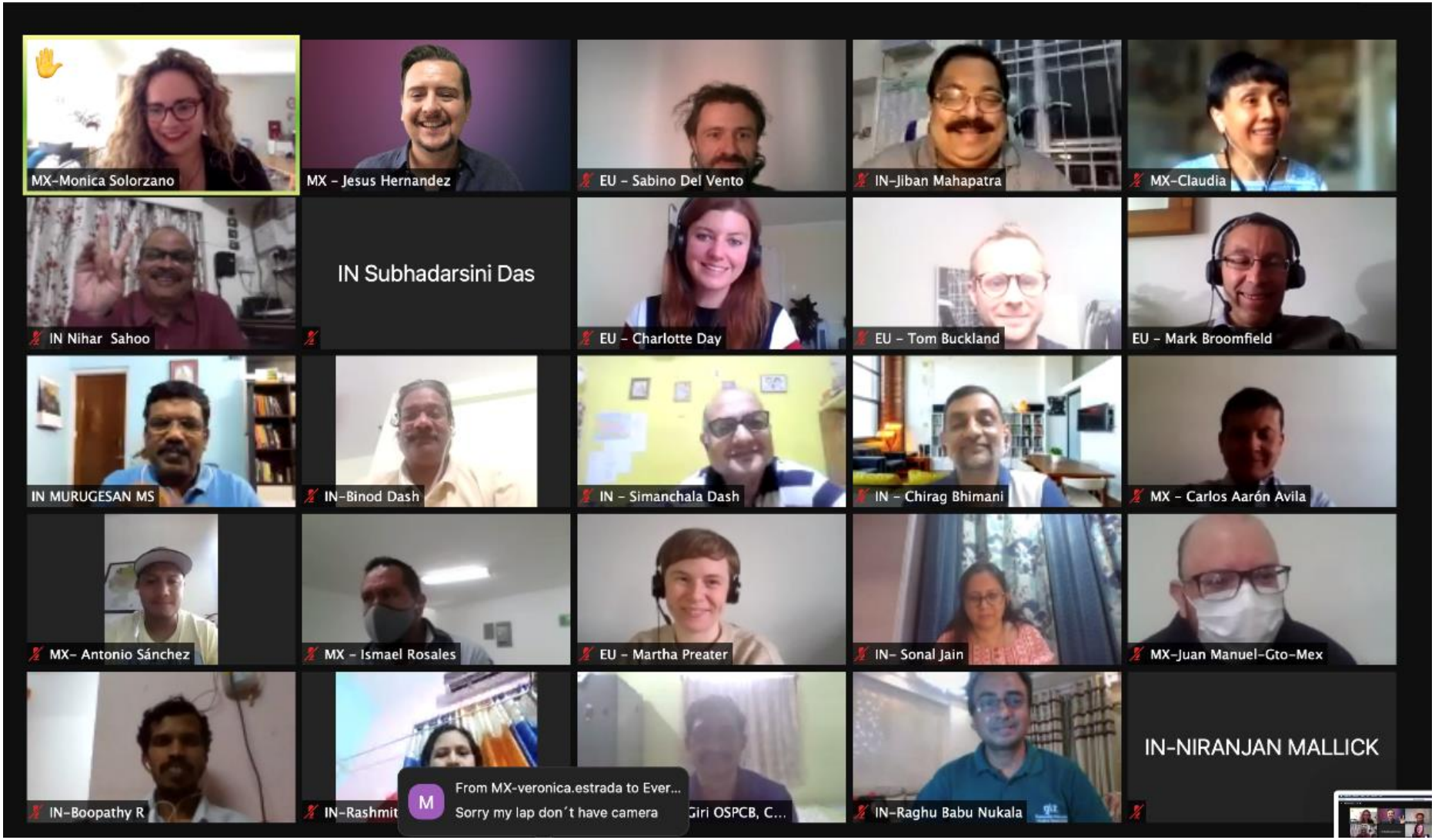


Figure A. 4: Output from group activity during day 2 of the second CoP event. Summary of notes from participants in Mexico (left) and India (right) regarding the potential challenges and leverage points related to their prototype projects.

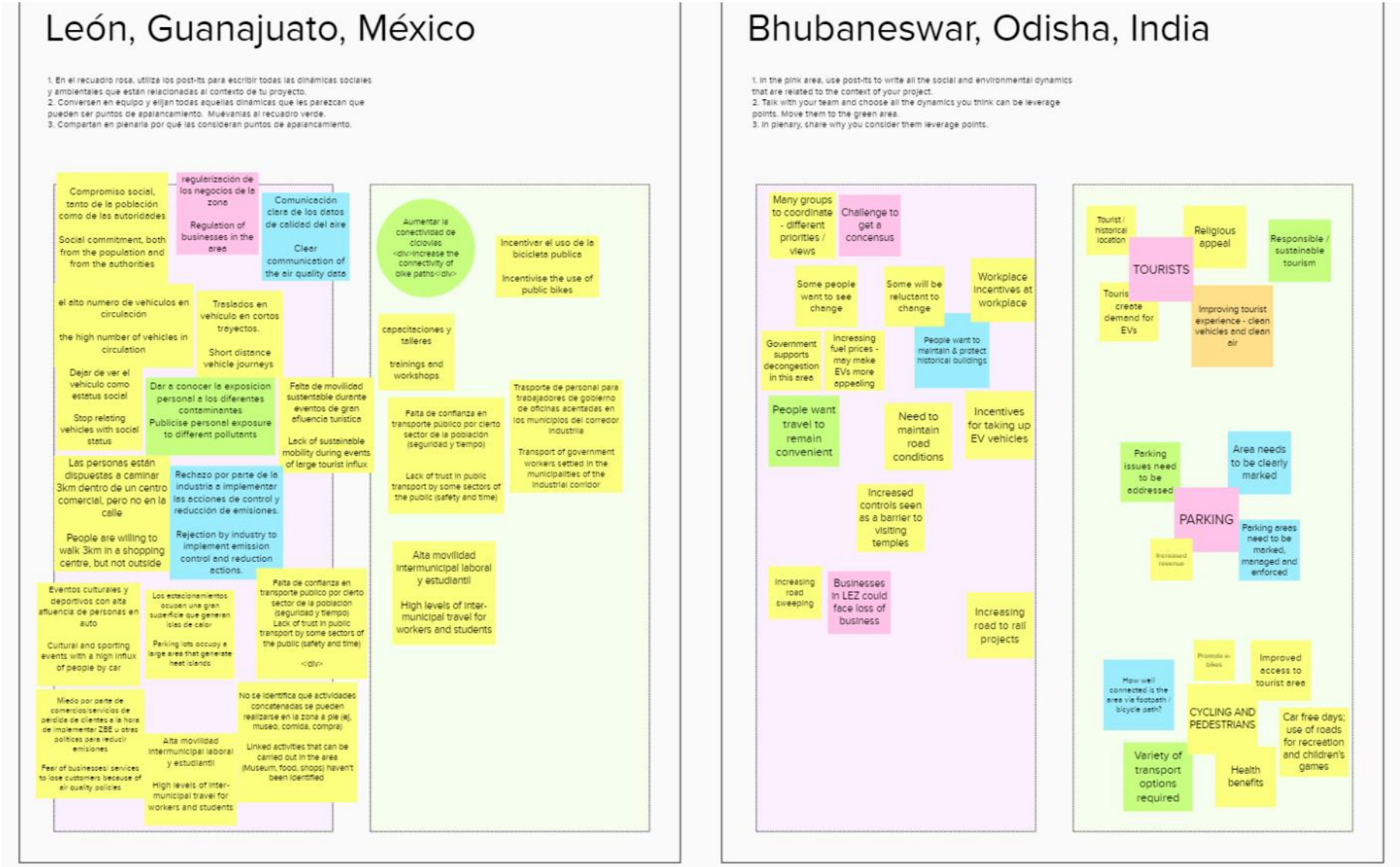


Table A. 1: Project governance model example produced by participants from Mexico during group discussion during day 2 of the second CoP event

Indicator *What you wish to achieve*	**Stakeholders** *Stakeholders that are required to participate*	**Roles/Functions** *The roles and functions each stakeholder holds*	**Mechanism** *The way Stakeholders should interact for the indicator to be achieved*	**Who is responsible?** *Direct contact for accountability*	**Needs input from** *What/Who does for this stakeholder*	**Gives output to** *What this stakeholder does for whom*
% acceptance between the general public and economic/ business units in the area	Social communication team of the municipal government	Communicate the conditions and benefits of the clean air zone to the population				
	Directorate of economic development	Create content and workshops on the environmental, social and economic benefits of the project	Create content for social communication and to convene and coordinate workshops with the population	Coordinator of communication		
	Environmental education team	Train, regulate and promote their participation in the project with business owners				

Table A. 2: Project Governance Model example produced by participants from India during a group discussion during day 2 of the second CoP event

Indicator *What you wish to achieve*	**Stakeholders** *Stakeholders that are required to participate*	**Roles/Functions** *The roles and functions each stakeholder holds*	**Mechanism** *The way Stakeholders should interact for the indicator to be achieved*	**Who is responsible?** *Direct contact for accountability*	**Needs input from** *What/Who does for this stakeholder*	**Gives output to** *What this stakeholder does for whom*
Restricting older vehicles (>15 years old)	Vehicle owners	Find an alternative method of travel / upgrade vehicle	Increase use of public transport	Housing & Urban Dev.	Transport Department, CRUT, Municipal Corp, Regional Transport Officer	
			Changing behaviours (shopping / working remotely)	Citizens,		

Indicator *What you wish to achieve*	**Stakeholders** *Stakeholders that are required to participate*	**Roles/Functions** *The roles and functions each stakeholder holds*	**Mechanism** *The way Stakeholders should interact for the indicator to be achieved*	**Who is responsible?** *Direct contact for accountability*	**Needs input from** *What/Who does for this stakeholder*	**Gives output to** *What this stakeholder does for whom*
			Engagement / communication with stakeholders - increasing awareness (local media, signage, public events, involvement of NGOs)			
			Increasing facilities for cycling and walking			
			Compensation / incentives			

Table A. 3: Results from data mapping exercise with notes from participants in India during day 3 of the second CoP event

Data required *Type of data / information required*	**What will it be used for?** *How will the data be used, and what will it allow you to understand?*	**When is the data required?** *At what stage in the project will the data be needed?*	**How to access the data?** *Which organisations / data providers will you need to contact to access the data? Will additional costs be incurred? Will specific permissions be required?*	**Barriers / challenges to accessing data** *What issues may you face in accessing the data? How can these be overcome?*
Air quality monitoring data (PM_{10} / $PM_{2.5}$) Potential NOx (not a priority) Noise impacts	Used to set the baseline, modelling assessments, communication, setting targets and monitor progress	Inception - throughout	Pollution control board - existing monitoring sites Additional monitoring sites - site specific data Combination of continuous monitoring station / low-cost sensors / manual monitoring	Funding allocations - need to identify Capacity building of officers - continuous and low cost
GIS information - maps / land-use data	Spatial planning Identifying location of monitoring stations Locations of other controls / green spaces Establishing the boundary Needs to coincide with heritage designation	Inception	Potentially available from Development Authority / Remote Sensing Application Centre	Strategically sensitive data Informal agreement
Meteorological data	Wind speed / direction & rainfall	Support modelling assessment	Meteorological department Airport	Informal agreement / potential charge Representative data / data gaps Options to use international met datasets

Data required *Type of data / information required*	**What will it be used for?** *How will the data be used, and what will it allow you to understand?*	**When is the data required?** *At what stage in the project will the data be needed?*	**How to access the data?** *Which organisations / data providers will you need to contact to access the data? Will additional costs be incurred? Will specific permissions be required?*	**Barriers / challenges to accessing data** *What issues may you face in accessing the data? How can these be overcome?*
Vehicle / traffic information - measured (vehicle counts, traffic density, fleet data, local vs external vehicles, vehicle classes)	Understand where vehicles are coming from and travelling to Understanding flow rates / types of vehicle Source apportionment	Support modelling assessment	Data may not be available - study required Opportunities to involve universities	Potential cost
Vehicle / traffic information - modelled				
Demographic statistics (population)			Census data available (2011) 2021 Census being completed -	
Public transport data				
Generator sets (type, size, fuel-type, technology, frequency)	Air quality modelling Source apportionment Enforcement / incentives for improvement	Impact assessment	Door to door survey Sales data Listing by property type - prioritise by building Information from electrical inspector	Public resistance

Table A. 4: Results from data mapping exercise with notes from participants in Mexico during day 3 of the second CoP event

Data required *Type of data / information required*	**What will it be used for?** *How will the data be used, and what will it allow you to understand?*	**When is the data required?** *At what stage in the project will the data be needed?*	**How to access the data?** *Which organisations / data providers will you need to contact to access the data? Will additional costs be incurred? Will specific permissions be required?*	**Barriers / challenges to accessing data** *What issues may you face in accessing the data? How can these be overcome?*
Mapping to define the area	To identify the ideal zone to establish the LEZ	At the start of the project	land register, satellite image etc.	Old or insufficient mapping resources
Origin-destination information in the area	Definition of the area	At the start of the project		
Emissions inventory for the zone				
Historical air quality data for the zone				
Personal exposure data				

Data required *Type of data / information required*	**What will it be used for?** *How will the data be used, and what will it allow you to understand?*	**When is the data required?** *At what stage in the project will the data be needed?*	**How to access the data?** *Which organisations / data providers will you need to contact to access the data? Will additional costs be incurred? Will specific permissions be required?*	**Barriers / challenges to accessing data** *What issues may you face in accessing the data? How can these be overcome?*
Analysis of vehicles circulating in the area				

Table A. 5: Example indicators produced by participants from India as part of group activities during day 2 of the third CoP event

Name of indicator	***Uptake of Electric Vehicles***	***Resident satisfaction***	***Provision of 100% electricity throughout the LEZ (at all locations)***
Description	*What is the uptake of EVs as a result of the LEZ?*	*Determining how satisfied the residents of the LEZ are with the project as a whole - including improvements in AQ, but also any events, supporting measures, how the zone operates, etc.*	*Provision of 100% electricity throughout the LEZ would allow for the diesel generator sets to be phased out, hence it's important to know if and when the electricity supply to the zone has been achieved.*
Calculation formula	*Number of EVs is required (before and after LEZ) - this will allow calculation of %.* *Percentage of the total vehicle fleet that is EV - possibility to break down by vehicle type?*	-	-
Measurement unit	*Number of EVs is required (before and after LEZ)*	-	-
Indicator character	*Increasing*	-	-
Baseline	*Current number of EVs (each vehicle type) & percentage*	-	-
Baseline Date	*Data is already available and kept up to date (vehicle database)*	-	-
Goal	*Unsure as baseline is not yet defined - proposed to carry out modelling to see what level of EV uptake would have the desired impact on air quality levels in the city, and work backwards from there*	-	-
Goal Date	*NCAP - 2024*	-	-

Verification item	*Consider the data on EVs at each quarter, and adjust the model as appropriate - then compare to the actual data collected* *Also need to consider if the model is working accurately in terms of predicting the % of EV uptake that will show the desired improvement in air quality*	-	-
Type of indicator	*Process*	-	-

Table A. 6: Example indicators produced by participants from Mexico as part of group activities during day 2 of the third CoP event

Name of indicator	***Decrease personal exposure to pollutants***	***Expansion of coverage of the public bike program in the ecozone***	***Penetration of the public bike programme in the zone***
Description	*Study to measure the personal exposure to pollutants in the ecozone (near schools)*	*Increase in coverage where the public bicycle program is implemented in the area. (considering an area of influence of 0.5km2 per public bike station)*	*Percent increase in the number of journeys completed with the public bikes.*
Calculation formula	*Average pollutant concentration with respect to the baseline (at hotspot areas/ school streets?)*	*Percentage of the area covered by the program in year x vs. percentage of the area covered by the program in year 0*	*Number of journeys travelled by public bikes in year x vs year 0*
Measurement unit	*% change*	*Percentage*	*Number of journeys travelled by public bikes*
Indicator character	-	*Increasing*	*Increasing*
Baseline	*Unknown*	*3%*	*300 journeys average per week*
Baseline Date	*2022*	*2021*	*2021*
Goal	*10% reduction from baseline*	*10%*	*500 journeys average per week*
Goal Date	*2024*	*2023*	*2023*
Verification item	*Personal Exposure Study Report*	*Annual study/ report of the public bicycle programme* *Maps of the ecozone where the coverage of the bike program is indicated*	*Annual study of the bike programme*
Type of indicator	*Impact*	*Product*	*Effect*

Figure A. 5: Aspects of the Breathable Cities Community of Practice for the activity on day 3 of the third CoP event

Figure A. 6: Results from the drawing activity showing participants' understanding of the relationship between aspects of the Breathable Cities community on day 3 of the third CoP event

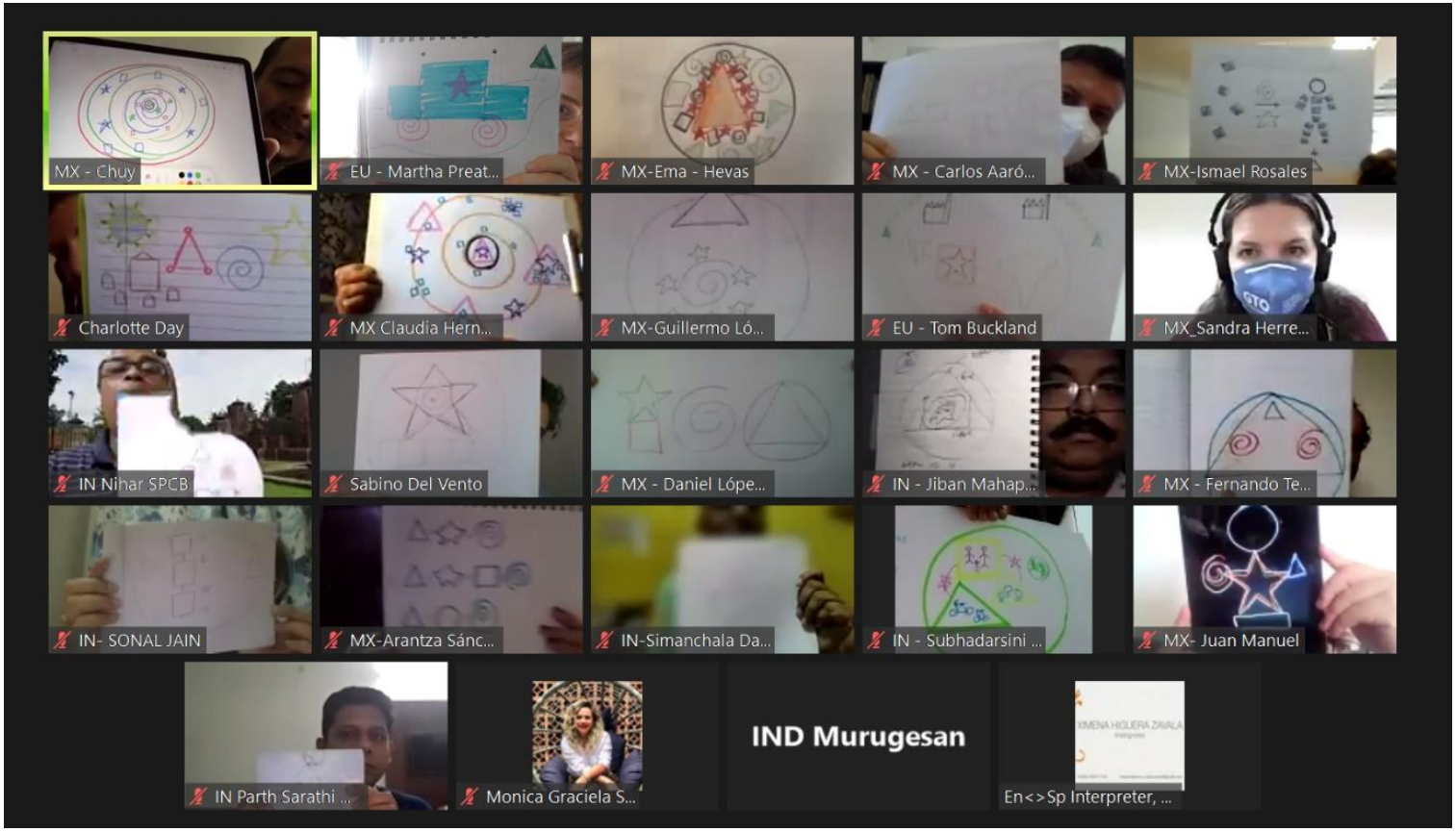


Figure A. 7: Group photo on the last day of the third CoP event

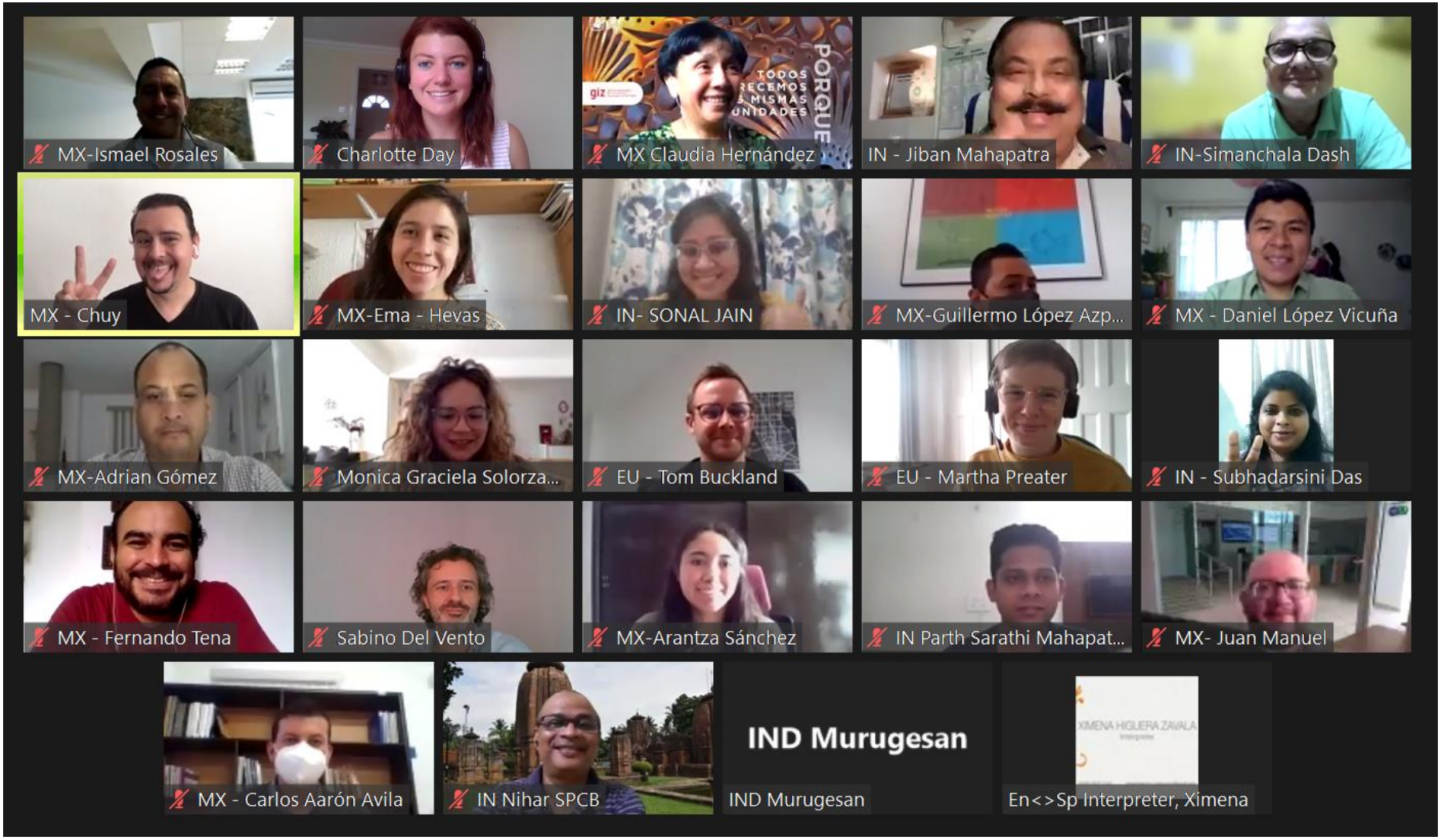


Figure A. 8: Participants in the Bhubaneswar CAZ / LEZ technical webinar

A2 Appendix 2 – MCA of air quality actions

The International Best Practice Report (see Section 2.1) comprised a review of best practices for managing and improving pollutant emissions from urban transport. The review identified examples of good practice across 45 transport-related air quality measures; these measures were then evaluated to assist in identifying which measures are likely to be the most useful for the cities. Multi-Criteria Analysis (MCA) was employed for the evaluation, according to the following criteria:

- **Air quality impact** – Score between 1 and 5 assigned based on the expected impact on pollutant emissions, measured concentrations, and other key indicators (e.g. smog). For example, air quality monitoring data would score 1, and a Low Emission Zone would score 5.
- **Costs** – Score between 1 and 5 assigned based on the expected overall cost. A measure expected to give a cost benefit would score 5. A measure with zero cost scores 4. A measure with an estimated cost of zero to INR 10 million scores 3. An estimated cost of INR 10 million to INR 100 million scores 2. An estimated cost greater than INR 100 million scores 1.
- **Prospective timescale** – Score between 1 and 5 assigned based on the expected time taken to see an air quality benefit. A measure with an immediate benefit (e.g. direct removal of emissions from a vehicle fleet) would score 5. A measure likely to be effective within one year scores 4. A measure likely to be effective within two to five years scores 3. A measure likely to be effective within five to ten years scores 2. A measure that is not likely to be effective for at least ten years scores 1.
- **Co-benefits** – Score between 1 and 5 assigned based on the expected number and scale of co-benefits. If a measure has multiple co-benefits likely to be felt by a significant proportion of the population, it scores 5. If a measure has few or no identifiable co-benefits then it scores 1.
- **Innovation** – Score between 1 and 5 assigned based on the novelty of the measure. For example, air quality monitoring networks are well-established in most cities so would only score 1. A new, automated, dynamic traffic system might score 5.
- **Reliance on other measures** – Score between 1 and 5 assigned based on the impact a measure can have, independent of other measures. A measure that is reliant on other measures to achieve an improvement in air quality (for example, air quality forecasting) would have a low score. A measure that, alone, is likely to achieve a significant improvement in air quality (for example, enforcement of emissions standards) would score 5.

The priority for any air quality action plan is to identify measures that reduce air quality impacts quickly and cost-effectively. To reflect this in the MCA, the first three criteria were applied a weighting of 100%, whilst the following three criteria were applied a weighting of 50%. The maximum score across the six criteria is therefore 22.5.

An air quality action plans should select actions based on the extent to which air quality is improved, the cost effectiveness, the timescales for implementation, the potential for a cross-cutting benefits, co-dependencies with other actions, and other criteria included in the MCA (as well as criteria that are not included). However, often there is a requirement for a trade-off between these criteria in order to identify a package of measures that is both beneficial, and achievable. The application of MCA shows us which measures scored well across a range of criteria and where there is likely to be a need for measures to be combined.

The evaluation is the result of the expert analysis of each measure by Ricardo Energy and Environment, based on the information available at the time, and before the team had been brought up to date with details of the different situation and priorities of Bhubaneswar and Cuttack. Table A. 7 presents the evaluation in full for all actions identified in the International Best Practice Report, organised by measure category. The results of the evaluation have been used to provide guidance as to which measures are likely to be the most useful for the Indian cities of Cuttack and Bhubaneswar (see Section 3.2).

Table A. 7 Evaluation of air quality measures from the International Best Practice Report, organised by measure category

Measure	Which pollutants are impacted?	Evaluation according to criteria						
		Air quality impact (1-5)	Costs (1-5)	Prospective timescale (1-5)	Co-benefits (1-5)	Reliance on other measures (1-5)	Innovation (1-5)	Weighted score (out of 22.5)
Weighting		100%	100%	100%	50%	50%	50%	
Direct emission control measures								
Driving bans / LEZs	NOx, PM	5	1	3	3	4	4	14.5
Emissions standards for private vehicles	NOx, PM	3	1	2	1	5	3	10.5
Emissions standards for public transport	NOx, PM, SO_2	2	1	2	2	2	3	8.5
Emissions standards for commercial vehicles	NOx PM SO_2	3	1	2	1	5	3	10.5
Anti-idling enforcement	NOx, PM	2	2	4	2	5	2	12.5
Smoky vehicle enforcement	PM	2	2	4	3	5	2	13
Enhanced street cleaning	PM	2	4	5	4	4	1	15.5
Road / path improvements & maintenance	PM	2	2	3	4	2	1	10.5
Sprinkling water at junctions	PM	1	3	5	3	5	1	13.5
Scrappage of 2-stroke 3-wheelers	NOx, PM	3	1	3	1	5	2	11
Fuel switching measures								
Low-emission bus fleets including retrofitting	NOx, PM, SO_2	3	2	4	3	4	4	14.5
Upgrade taxis including retrofitting	NOx, PM	2	2	3	3	5	4	13
Incentives for cleaner vehicles	NOx, PM	4	2	3	3	4	4	14.5
New technologies measures								

Measure	Which pollutants are impacted?	Evaluation according to criteria: Air quality impact (1-5)	Costs (1-5)	Prospective timescale (1-5)	Co-benefits (1-5)	Reliance on other measures (1-5)	Innovation (1-5)	Weighted score (out of 22.5)
Weighting		100%	100%	100%	50%	50%	50%	
Electric buses	NOx, PM, SO_2	3	1	2	3	1	5	10.5
Electric taxis	NOx, PM	2	1	2	3	1	5	9.5
Comprehensive electric charging infrastructure	NOx, PM, SO_2	4	1	1	3	1	5	10.5
E-bikes / pedelecs including E-delivery vehicles	NOx, PM, SO_2	3	2	4	3	2	5	14
Compressed Natural Gas	NOx, PM, SO_2	2	1	2	2	1	4	8.5
Active dust binding	PM	2	4	5	1	5	4	16
Mode shift measures								
Public transport infrastructure and service quality	NOx, PM	3	4	2	5	2	3	14
Discounted / intermodal tariff offers and networking in public transport	NOx, PM	3	4	4	5	1	4	16
Cycle network	NOx, PM	2	4	3	5	2	2	13.5
Priority bicycle routes / junctions	NOx, PM	2	3	3	5	2	4	13.5
Footpath network	NOx, PM	2	3	3	5	2	2	12.5
Municipal mobility management	NOx, PM	2	4	4	4	1	4	14.5
Corporate mobility management	NOx, PM	2	3	3	3	1	4	12
Car sharing	NOx, PM	2	2	4	4	2	4	13
Bike rental	NOx, PM	2	3	5	4	2	4	15
Transport and urban planning measures								
Dynamic traffic management	NOx, PM, SO_2	3	2	4	4	4	5	15.5
Environmentally sensitive truck routing	NOx, PM, SO_2	3	4	2	4	4	2	14

Measure	Which pollutants are impacted?	Evaluation according to criteria: Air quality impact (1-5)	Costs (1-5)	Prospective timescale (1-5)	Co-benefits (1-5)	Reliance on other measures (1-5)	Innovation (1-5)	Weighted score (out of 22.5)
Weighting		100%	100%	100%	50%	50%	50%	
Parking controls	NOx, PM	4	3	2	3	4	2	13.5
Parking guidance system	NOx, PM	2	1	3	5	4	4	12.5
Traffic flow smoothing	NOx, PM, SO_2	2	4	4	4	2	5	15.5
Speed limits	NOx, PM, SO_2	2	3	2	3	3	2	11
Air quality monitoring and data measures								
Collection of air quality data	NOx, PM, SO_2	1	4	4	2	2	3	12.5
Collection of mobility / transport data	NOx, PM, SO_2	1	4	4	4	2	4	14
Air quality forecasting	NOx, PM, SO_2	1	5	3	2	2	5	13.5
Communication and engagement measures								
Promotion of Park & Ride / Bike & Ride	NOx, PM	3	4	2	5	1	3	13.5
Promotion of EVs	NOx, PM	4	5	3	5	1	5	17.5
Promotion of cycling	NOx, PM	3	4	4	5	1	3	15.5
Displays of current / future air quality	NOx, PM, SO_2	1	4	5	1	1	4	13
City-wide mobility campaign	NOx, PM	2	4	4	5	2	4	15.5
Dynamic passenger information system	NOx, PM	2	5	3	5	2	5	16
Website for rules / regulations relating to air quality	NOx, PM, SO_2	1	4	5	2	1	3	13
'Car Free Day' and other promotions	NOx, PM	2	3	4	4	2	4	14

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