D6.2 Behavioural change techniques for hackAIR community

WP6 – Engagement strategies for user participation

Document Information

Grant Agreement Number	688363	Acronym	hackAIR	
Full Title	Collective awareness platform for outdoor air pollution			
Start Date	1st January 2016	Duration	36 months	
Project URL	www.hackAIR.eu			
Deliverable	D6.2 Behavioural change techniques for hackAIR community			
Work Package	WP6 – Engagement strategies for user participation			
Date of Delivery	Contractual	31 August 2017	Actual	15 September 2017
Nature	Report	Dissemination Level	Public	
Lead Beneficiary	VUB			
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Document History

Version	Issue Date	Stage	Description	Contributor
0.1	23/03/2017	Draft	Table of contents	Carina Veeckman (VUB)
0.2	17/07/2017	Draft	Draft for internal review	Katharina Hoelck (VUB)
0.3	07/08/2017	Draft	Draft for consortium review	Wiebke Herding (ON:SUBJECT), Panagiota Syropoulou (DRAXIS)
0.4	25/08/2017	Draft	Draft for internal review	Katharina Hoelck (VUB), Gavin McCrory (VUB), Carina Veeckman (VUB), Laurence Claeys (VUB)
0.5	06/09/2017	Draft	Draft for final review	Katharina Hoelck (VUB), Carina Veeckman (VUB), Laurence Claeys (VUB), Gavin McCrory, Wiebke Herding (ON:SUBJECT), Panagiota Syropoulou (DRAXIS)
1.0	15/09/2017	Final	Final submission	Katharina Hoelck (VUB), Gavin McCrory (VUB)

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Executive summary

The overall objective of work package 6 (WP6) is to develop an effective strategy for promoting the adoption and usage of the hackAIR platform. WP6 consists of three tasks: First, to create engagement strategies for encouraging the involvement of new members in the hackAIR community; second, to develop strategies to encourage members to change their behaviour towards air quality, and; third, to develop appropriate social media monitoring tools to support the implementation of such these strategies.

This deliverable (D6.2) reports on the second task within WP6 by designing strategies to bring about behavioural change to fight air pollution. The implementation and execution of the developed strategies will take place in WP7 "Pilot operation and evaluation". At the moment, this deliverable provides a tentative timeline and estimate of resources for behavioural change interventions; a detailed time plan will be agreed on with project partners during the next meeting in Amsterdam in October 2017.

The deliverable starts by addressing behavioural change through a conceptual inquiry. Accordingly, a literature review about theories of behaviour, models of behavioural change, and frameworks for behavioural change is conducted. Then, the relevant insights of the models and theories for hackAIR, as well as the framework used to design the behaviour change strategy within hackAIR are outlined.

As a next step, behavioural change is addressed through an empirical inquiry, both by learning from existing projects as well as the user. To this end, the deliverable contains a mapping of projects, i.e. significant projects that were conducted in the past decade around air quality and reports about expert interviews with their representatives. Best practices of these studies are listed and taken into account for the behaviour change strategy of hackAIR. Subsequently, the design and results of a survey conducted through the support of BUND and NILU are reported. Insights from a user perspective are derived and added to the behaviour change strategy of hackAIR.

Finally, the insights of the conceptual and empirical investigation are combined, and are used to inform the development of a behavioural change strategy for the hackAIR community. For this purpose, the introduced framework, the 'Modular Behavioural Analysis Approach' (MBAA), is applied. First, the conceptual design of the strategy is explained. The strategy is based on an understanding of behaviour as being formed of not only intentions but also habits as well as the social marketing, diffusion and stages of change model. Then, the empirical design of the strategy is introduced. This includes the used methodology, i.e. experiments, and the behavioural change strategies and tools employed within the set-ups.

The impact of possible interventions for behavioural change will be investigated in three experiments within the behavioural change strategy for hackAIR. The experiments will address the generation of social collectivism through offline community events (experiment 1), providing information via 'tips of the day' online (experiment 2), and gamification on the hackAIR platform online (experiment 3).

In D7.7: "Pilot implementation and final evaluation report: pilot performance and impact of hackAIR", the final results of the implementation of the behavioural change strategy will be included. The next step will be to carry out and test the designed interventions. While a tentative planning was laid out in this deliverable, a meeting with all project partners in October in Amsterdam will help to further refine the strategy and detail the suggested timeline.

Introduction

1.1 Deliverable information

The presented deliverable (D6.2) is part of the larger WP6 which is concerned with the development of an effective strategy for promoting the adoption and usage of the hackAIR platform. WP6 consists of three tasks: The first task is concerned with the creation of engagement strategies for encouraging the involvement of new members in the hackAIR community, the second task aims to develop strategies to encourage members to change their behaviour towards air quality, and the third task includes the development of appropriate social media monitoring tools to support the implementation of such these strategies. The deliverable on hand (D6.2) reports on the second task within WP6.

1.2 Research purpose

This deliverable (D6.2) reports on the development of a behavioural change strategy for hackAIR, which should contribute to the fighting of air pollution. Concretely the deliverable follows the following questions of inquiry:

- *Which theoretical concepts of behavioural change are relevant for the hackAIR project?*
- *How should behavioural change for air pollution be designed from an empirical viewpoint?*
- *What behavioural change approach is suitable for hackAIR?*

The first question addresses the objective of the deliverable from a conceptual point of view. Accordingly, a literature review was conducted to explore how to bring about lasting behavioural change towards pro-environmental behaviour, with a specific focus on approaches that could be applied in the hackAIR project. Attention was being paid to the link between the engagement strategies (as reported in D6.1) and behavioural change in order to ensure that both tasks link up and that engagement would lead to informed and aware citizens towards air quality.

In addressing the objectives of the deliverable from an empirical point of view, question two was approached from two angles. First, by learning from existing projects. Behavioural change strategies in previous projects targeting air quality were mapped and representatives interviewed. Initially, a focus group and co-creation sessions with different user groups was planned to inform the strategy. However, it became clear during the project that conducting focus groups and co-creation sessions after the launch of the hackAIR platform would be of more value, as it would allow an actual evaluation of the use of the platform and the behaviour change strategy to take place. It was agreed to include a comprehensive mapping of projects in the area of air quality into this deliverable, complimenting insights generated from expert interviews with representatives of the most relevant projects (see D6.1: Engagement strategy for hackAIR community involvement).

Second, by learning directly from the user. Accordingly, a survey was conducted with the support of BUND and NILU to map opportunities and barriers regarding defined changes in behaviour. Insights from a user perspective were derived and added to the behaviour change strategy of hackAIR. Also, it was deemed suitable to launch the survey in two itineraries: first, to the members of BUND and employees of NILU, which should due to their pre-engagement in an environmental organisation have a great readiness to participate in the project. Second, to the general public and different demographic groups (D2.2: User and technical requirement analysis) which were identified as important target groups for the project e.g. people with respiratory diseases.

In tackling question three, findings from literature, practical data collection and user insights have been combined to develop a behavioural change strategy for hackAIR. This strategy will then be applied through a survey process and a number of both physical and digital behaviour change experiments.

1.3 Structure

The overall structure of the deliverable is displayed in Figure 1, and outlines the outputs from conceptual and empirical in contributing towards the definition of the behavioural change strategy for hackAIR.

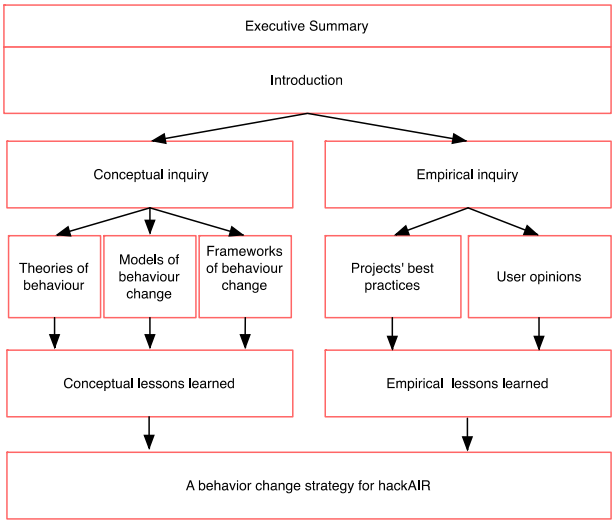


Figure 1: Structure of hackAIR D6.2

Chapter 2 comprises the results of a comprehensive literature review about theories of behaviour, as well as models and frameworks for behavioural change. *Lessons learned are then derived for the conceptual design of the behavioural change strategy for hackAIR.*

Chapter 3 maps significant behaviour change projects that occurred in the past decade around air quality and reports the results of expert interviews with representatives of the most interesting projects. The results are taken into account for the empirical design of behaviour change strategies for hackAIR. Subsequently, the chapter presents the results of the conducted survey. Barriers and enablers in behaviour for positive effects towards air quality are derived and likewise considered when designing the behavioural change strategies. *Lessons learned for the empirical design of the behavioural change strategy for hackAIR are derived.*

Chapter 4 builds on the lessons learned of the two previous chapters and defines a behavioural change strategy for the hackAIR community. In this final chapter, the conceptual and empirical design of the envisioned behavioural change strategy for hackAIR is presented as well as first results, i.e. of the beginning of the survey process. The future planning and milestones are outlined for the implementation of the remaining strategy, i.e. of the upcoming survey results and experiments.

It is important to note that this deliverable describes the strategies and their implementation and not the complete results of the actual implementation; in close collaboration with BUND and NILU, the strategies will be implemented and if necessary adapted to the specifics of the pilot location over the next year. Final results will be reported in D7.7 “Pilot implementation and final evaluation report: pilot performance and impact of hackAIR” (M36, Dec 2018).

2 Conceptual inquiry: Theories of behaviour, models of behavioural change, and frameworks for behavioural change

This chapter examines theoretical concepts of behavioural change that are of relevance for the hackAIR project. For example, how can such a change of behaviour, i.e. "a push for the right choice" become informed and influenced by a range of theories, models, and frameworks? In the following sections, findings from a literature review is outlined, including an assessment of theories of behaviour, models of behavioural change, and frameworks for behavioural change. After each section, insights for the hackAIR project, i.e. for behavioural change for fighting air pollution are extracted and the general conceptual outline of a behavioural change strategy for hackAIR is developed. As mentioned above, attention has been paid to the link between the engagement strategies (as reported in D6.1) and behavioural change in order to ensure that both strategies are aligned.

2.1 Introduction to behavioural change

Behavioural change approaches originate from the social sciences or psychology and mainly differentiate themselves through their specific focus (Darnton, 2008a). In general, however, they share a common acknowledgement that humans are not rational (see e.g. Dawnay and Shah 2005); rather, they are emotional, influenced by their context and other individuals. As a result, it is possible to observe a huge gap between the (usually rational) intentions and actual actions of most people (see also Blake, 1999). As an example: around New Year a lot of good intentions are formulated, e.g. to smoke less or to do more sports with presumably positive effects on health or money spent. These intentions, however, are seldom followed through. Behavioural change approaches try to overcome this 'intention-action gap' by designing an environment that pushes or facilitates the right choices.

In general, it is possible to distinguish between theories of behaviour, models of behavioural change and complete frameworks for behaviour change. The following distinctions can be made:

- Theories of behaviour can help to explain specific behaviours by identifying the underlying psychological determinants that influence them. Hence, these theories are relevant on the level of the individual.
- Models of behaviour change explain how behaviour can be changed over time, i.e. from one type of behaviour (behaviour A) to another one (behaviour B). Models of behaviour change usually build on theories of behaviour to explain how and when change happens.
- Frameworks for behavioural change are based on models and theories. They are more practical and can guide the design of actual interventions that should elicit behavioural change. This change is usually directed towards a certain target group or population.

Hence, theories of behaviour, models of behavioural change, and frameworks for behavioural change are necessary for the conceptualisation of a strategy (see also Sweeny, 2009; Darnton, 2008b). Figure 2 situates all three descriptions regarding the assessment of behavioural change.

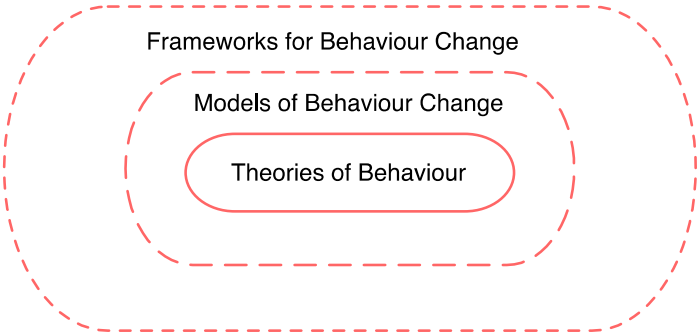


Figure 2: Theories, models, and frameworks for behavioural change

In the following review, the most relevant theories, models, and framework are discussed in further depth before they are used to inform the development of a conceptual design of a behavioural change strategy for hackAIR.

2.2 Theories of behaviour

In order to examine which theoretical concepts of behavioural change are relevant for the hackAIR project, it is necessary to understand behaviour per se. As alluded to above, theories of behaviour identify the underlying psychological factors that influence the behaviour of individuals. Therefore, they can help to understand individual's attitude, agency, and norms and consider contextual factors. In the following section, three selected theories of behaviour are explained in further depth: 1 the expectancy value theory, 2) the theory of planned behaviour, and 3) the theory of interpersonal behaviour.

2.2.1 Expectancy value theory (EVT)

As Darnton (2008b) outlines, the attitude of an individual is often at the core of most behavioural models. This attitude is typically captured by a strand of theories that are referred to as expectancy value theories (EVT). Expectancy value theory (EVT) as known within psychology, economics and communication studies, goes back to the work of psychologist Martin Fishbein (1963). In its core, the theory states that an individual's behaviour is goal-directed and determined by how high the individual values a goal and how likely the individual expects it to be achieved. The individual is thus forming pairs of belief and value for certain possibilities to behave. Accordingly, the individual will calculate and then select the behaviour that constitutes the best combination of expected success and value. As an equation, this consideration looks as follows:

$$A_o = \sum_{i=1}^{n} b_i e_i$$

A_o describes hereby the attitude toward the object, b_i the belief about the object's possession of the attribute, e_i the evaluation of the attribute as being good or bad, and *n* is the limited number of attributes that an individual will consider. Hence, the individual's attitude, i.e. the result of the individual's calculation, will guide their behaviour. This means that individuals' beliefs have to be assessed in detail to be able to estimate the effect on attitude.

With the time, Fishbein expanded with Ajzen the expectancy-value theory into the theory of reasoned action (TRA) (Fishbein & Ajzen, 2010). The TRA argues that attitudes are assessed with regard to the behaviour performed rather than objects. This behaviour is determined by behavioural intentions, i.e. the decision to perform a certain behaviour

depends on not only personal attitudes towards the behaviour, but also by subjective norms. Attitude is again predicted by beliefs and the valuation of the result of the behaviour. Subjective norms are predicted through normative beliefs and the tendency to comply with those beliefs (see also Towler & Shepherd, 1992).

Adjustments have been made over time, including the inclusion of more and more factors. A further prominent outcome is for example the model of Jacquelynne S. Eccles. Eccles included further factors that influence an individual's behaviour including their gender, race, and ethnicity (Eccles & Wigfield, 2002). Summing up, the EVT emphasises the importance of considering peoples' attitudes, namely their beliefs and expectations. Hence, these should be considered when conceptualising a behavioural change strategy for hackAIR, but also when designing the empirical part of strategy.

2.2.2 Theory of planned behaviour (TPB)

The theory of planned behaviour (TPB) can be regarded as a further extension of the TRA by Ajzen (1985). The TPB not only pays attention to individuals' attitudes, but also elaborates significantly on norms and includes agency. Accordingly, human action is guided by (1) behavioural beliefs about the consequences of behaviour, (2) normative beliefs about the expectations of others, and (3) control beliefs about factors that might influence the performance of behaviour. Figure 3 displays the whole model.

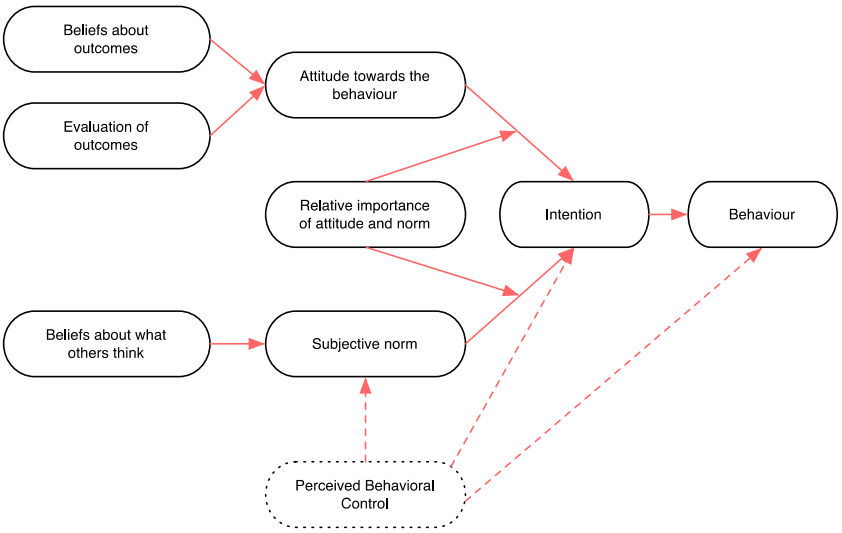


Figure 3: Theory of planned behaviour (TPB). Source: Ajzen (1985)

A first additional parameter compared to the EVT are normative beliefs, previously introduced in the TRA; in this model, they are referred to as 'subjective norms'. They describe the beliefs of an individual about what others are expecting of him or her in terms of behaviour. As such, they are a "guide to how we should behave, and how we expect others to behave" (Darnton, 2008b). The second additional and new parameter in the model is a control parameter and increases significantly the explanatory power of the TPB. It is referred to in the model as 'perceived behavioural control'. This parameter makes it possible to acknowledge that behaviour is not completely voluntary. Indeed, as Darnton (2008b) outlines, Ajzen (1985) is thus incorporating contextual factors by placing them within the agency construct. As Ajzen (2011) himself outlines, some authors reject the TPB outright, instead advocating a solemnly unconscious approach towards behaviour (e.g. Wegner, 2002). In general, however, the theory is highly popular and

widely accepted, with critics only demanding inquiry into its limiting conditions (see e.g. Fishbein & Ajzen, 2010). Consequently, the TPB adds the impact of beliefs in the form of subjective norms. Hence, the importance of expectations of others in a social environment should be taken into account, also designing and testing a behavioural change strategy for hackAIR.

2.2.3 Theory of interpersonal behaviour (TIB)

The Theory of Interpersonal Behaviour (TIB) as introduced by Triandis (1977), can be regarded as an alternative to Ajzen's (1985) TPB, although it is less widely used. The theory allows including an even greater number of contextual factors. The theory includes contextual factors at several points, thus providing a balanced approach towards an individual's behaviour, consciousness and unconsciousness. Figure 4 summarizes the theory.

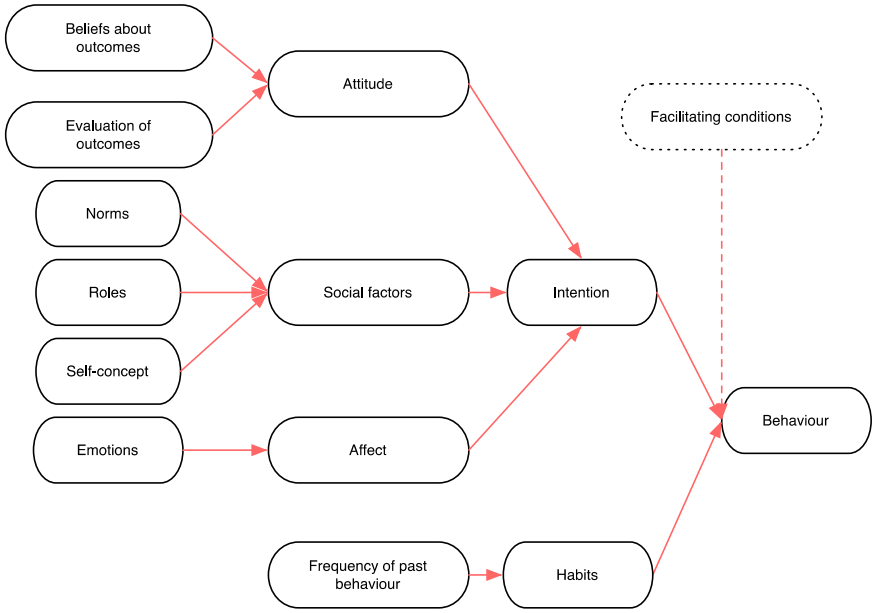


Figure 4: Triandis' theory of interpersonal behaviour (TIB). Source: Triandis (1977)

The influence of contextual factors can be seen in the factor 'facilitating conditions' that the authors included. These entail next to external factors such as the availability of finding information, a person's ability to act, their state of arousal and their knowledge of the behaviour (Darnton, 2008a). Additionally, the theory includes habits as another factor that can directly influence behaviour. Habits are not influenced by the other factors in the model such as attitude and social factors, which both influence an individual's intention and occur automatically. Furthermore, Triandis (1977) also acknowledges the role of emotion and social factors, contrary to the TPB.

All in all, while the TPB's main underlying constructs are beliefs, the main underlying construct of the TIB are habits (Darnton, 2008b). Indeed, Triandis (1977) emphasised that the role of habits increases with time, to the disadvantage of intentions. The more often behaviour is repeated, the more habitual and thus less voluntary it becomes. Summing up, contextual factors should be considered. Also, next to intentional behaviour, habits should be taken into account when designing a behavioural change strategy for the hackAIR community.

2.2.4 Towards a behaviour change strategy for hackAIR: Conceptual lessons learned I

By considering the above theories of behaviour, it is possible derive some lessons learned for the development of a behavioural change strategy for hackAIR.

Conceptual inquiry I
• *Behaviour has both intentional and unintentional (habitual) elements* • *In addition to attitude, social norms are decisive and triggered by social expectations.*

These lessons learned have several implications moving forward. First, given to the intentional and unintentional aspects of behaviour, participants should be asked about both specific and routine behaviours when assessing behaviour for hackAIR. Second, due to decisiveness of social norms, the behavioural change strategy of hackAIR should explore behavioural change not only in isolated environments e.g. in front of a smartphone screen, but also in interactive group settings, such as workshops.

2.3 Models of behavioural change

After attempting to understand what determines behaviour, it is possible to further explore how behaviour can be changed over time. As alluded to above, theories of behavioural change try to explain a change from one behaviour (behaviour A) to another behaviour (behaviour B). In the following sections, three models targeting behavioural change are explored in depth. For this purpose, models were chosen that provide not only theoretical explanations but also potential for practical application. The following models are discussed: 1) the behavioural change approach of social marketing, 2) Rogers' diffusion of innovation theory, and 3) Prochaska and Di Clemente's stages of change theory.

2.3.1 Social marketing

Social marketing includes "efforts focused on influencing behaviours that will improve health, prevent injuries, protect the environment, contribute to communities, and, more recently, enhance financial well-being" (Lee & Kotler, 2013, p. 8). It can be thus regarded as a procedure with the aim of fostering a valuable behaviour change in the public interest. Models used within social marketing are usually research-based, but also aim at the same time to offer practical, step-by-step guides. A broad range of approaches exist within social marketing, addressing specific issues such as health or environmental behaviour (Darnton, 2008b). One of these approaches was outlined by Lee and Kotler (2013). Within their approach, the authors provide a clear and highly applicable model of behaviour change. In doing so, they outline three types of objectives relevant for behavioural change:

1. Belief objectives: what do you want your audience to believe or feel?
2. Knowledge objectives: what do you want your audience to know?
3. Behaviour objectives: what do you want your audience to do?

Belief objectives are related to attitudes, opinions, feelings or values. It might be that a current belief needs to be changed, or that an important belief is missing. Knowledge objectives are mostly related to statistics, facts, as well as other information and skills that a given target audience might find motivating or important. Behaviour objectives should be translated into a list of single and doable behaviours that are explained in simple and clear terms. A prioritisation can also be made to know where to spend the most effort. Furthermore, Lee and Kotler (2013) emphasise

that during the further delineation of behaviour change objectives, it is essential to consider the following elements: impact, willingness, and measurability. Impact refers to the extent that a specific behaviour makes a relative difference in the overall behaviour change campaign. Willingness refers to acquaintance and interest of the participating individuals regarding the envisioned behavioural change. Finally, measurability is important; it must be possible to observe, record or self-report any defined behavioural change objectives.

The 7E-model (Bambust, 2015) took inspiration from social marketing. It was developed based on the so-called 4E-model, developed by Defra in the UK in order to steer actions by governmental bodies with regard to sustainable lifestyles. Both models introduce a number of leverages starting with the letter 'E'. The original 4 E's from the Defra's model are 'engage', 'enable', 'encourage', 'exemplify'. The three new levers are called 'enthuse', 'enlighten', and 'experience'. The explanation of the levers below highlights how the 7E-model refines some of the 4E's stated by Defra.

Three levers work on increasing motivation towards the action (Bambust, 2015):

1. *Enthuse*: make people enthusiastic (intrinsic motivation). Connect to personal values and concerns within your target audience and from that point portray the content and positive aspects of the behaviour and the consequences for them. Mention a possible loss, but frame why they will benefit from it in the end.
2. *Encourage*: portray the potential benefit (extrinsic motivation). This can be done by a) offering a concrete reward for the target population or b) in case one cannot really demonstrate a concrete observable financial or material reward, work on honour and recognition that is given in a timeframe close to the performed action.
3. *Engage*: show that a group of people are behind the action (social motivation). This means working on 3 points: support the group who is performing the activity, show this group (put them in the spotlights) and feel the presence of the group. In other words, present the group to your target audiences as ambassadors and ensure these ambassadors can be seen and reached.

Three leverages are working on providing support towards the action:

4. *Enlighten*: provide information. It is important that this information makes us enthusiastic, supports us when making the choice to act and provides us with information on how to act or with information when we are acting.
5. *Exemplify*: show the example with policies and other measures. Do not tell to people that you are working for their benefit, but prove it also with your own deeds and personality. It is about providing trust to your organisation, its operations and its members.
6. *Enable*: provide tools to act. In other words, this is about removing as many barriers as possible to perform a behaviour (make sure it becomes easy, simple and possible) and assist people with the process of learning to perform the act.

One lever focuses on providing experience with respect to a desired behaviour:

7. *Experience*: let people experience the behaviour in a positive way and see that they made a good choice. In order to fulfil this objective, it is important to a) let people experience the meaning of the behaviour, b) ensure all contextual factors for the behaviour are congruent in order to provide a total experience, c) remain attentive to the steps leading towards the behaviour (prequel) and the processing of the behaviour (sequel).

In order to put the 7E's at work in a strategy, it is important to situate them within a wider framework (see also Bambust, 2015). In summary, changing behaviour can be concretely achieved by defining certain belief, knowledge, and behaviour objectives and taking into account the 7E's to design intervention tactics. When defining those

objectives and tactics for hackAIR, it will be essential to take into account the impact of the envisioned objectives, the willingness of the participants to perform them, as well as the measurability of the objectives.

2.3.2 Diffusion model

A further interesting model is the Diffusion model of Rogers (2003). Models of diffusion describe how a behaviour spreads. Rogers' 'Diffusion of innovation theory' is probably the best known among this type of model. By illustrating how people pick up and adopt new ideas and services, it is most often used to describe how individuals accept new technology. Rogers (2003) distinguishes between five categories of people who adopt innovations at different speeds: Innovators, early adopters, early majority, late majority, and laggard segment. Figure 5 shows how these segments are usually distributed among adopters of new technologies. Innovators are the smallest proportion, while most individuals adopt a technology as part of the 'early' or 'late' majority.

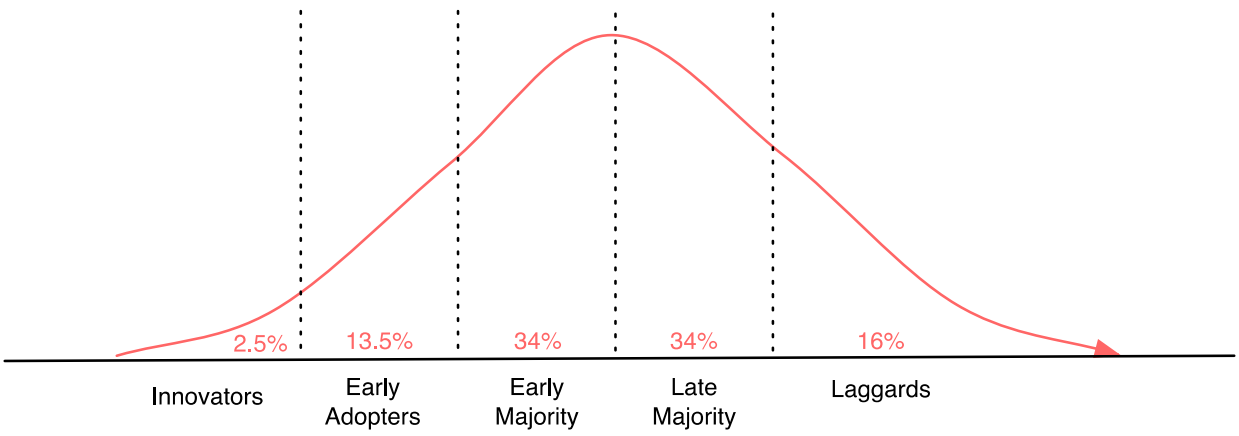


Figure 5: Rogers' diffusion model. Source: Rogers (2003)

The first segment is indeed the most eager to pick up a new innovation, while the latter segments are more reluctant. Rogers (2003) stresses that each segment looks to the one before them in their decision to adopt or not adopt a new technology. Giving an example, early adopters influence the early majority. In this context, building upon the work of Paul Lazarsfeld, Rogers (2003) points to the role of 'opinion leaders' in spreading new ideas and technologies in society: people are more influenced by personal contact and the information they receive from opinion leaders than to mass media messages. Summing up, individuals adopt ideas, services or technologies with diverging speed. This pattern can also be expected to occur within the hackAIR project when it comes to the adoption of behaviour.

2.3.3 Staged model

The stages of change model by Prochaska and Di Clemente (1984) was originally developed in the context of changing behaviour for health, as well as the actions needed to move from one type of behaviour to another. The model, also referred to as the 'Transtheoretical Model' proposes five stages through which people must progress in order to change their behaviour: 1) pre-contemplation, 2) contemplation, 3) preparation, 4) action, and 5) maintenance. The authors identify the characteristic and measurement strategies (a 6-months period) for each respective stage, and

outline actions needed to move from one stage to the other. Table 1 displays the stages of change and describes the strategy/action needed.

Stage 1: Pre-contemplation	Stage 2: Contemplation	Stage 3: Preparation	Stage 4: Action	Stage 5: Maintenance
No intention to change behaviour in the foreseeable future, no awareness, or hardly no awareness about the topic	People are aware, knowing where you want to go but not quite ready yet	In the process of decision making and having the intention to take action	Behaviour is modified, first experiences to overcome the problem	Changing habits, consolidating the gains versus efforts
Strategies: information, conscious raising	Self-re-evaluation	Finding support, believing in one's capability	Rewards for positive behaviour, reminders and cues	Rewards for positive behaviour, reminders and cues

Table 1: Lee & Kotler's stages of change

The 'stages of change' model describes a change in an individual's behaviour towards a more positive outcome. It is explicitly addressing intentional change, i.e. change consciously introduced through decision-making. Its core constructs are therefore the processes of change per se, decisional balance, self-efficacy, and temptation. In conclusion, the staged model makes it possible to divide behaviour change into more detailed changes of change and propose specific strategic possibilities to foster the development from one stage to another. These stages can also inform the conceptualisation of a more detailed behaviour change strategy of hackAIR.

2.3.4 Towards a behaviour change strategy for hackAIR: Conceptual lessons learned II

From the discussion of the above models of behaviour change, it is possible to derive lessons learned for the development of a behavioural change strategy for hackAIR.

Conceptual inquiry II
1. Behaviour can be changed through a process of changing beliefs, knowledge and behaviour objectives. 2. The 7E model introduces hands-on levers to change citizen behaviour towards a more sustainable lifestyle. 3. Change happens in stages and follows models of diffusion.

These lessons learned have several implications for the design of a behavioural change strategy for hackAIR. First, the insight that behaviour change is based on a process of changing belief, knowledge, and behaviour objectives is essential when understanding how behaviour change can be evoked. Within the behavioural change strategy for hackAIR, the level of advancement of these objectives will be identified and then aims to be further advanced (Figure 6).

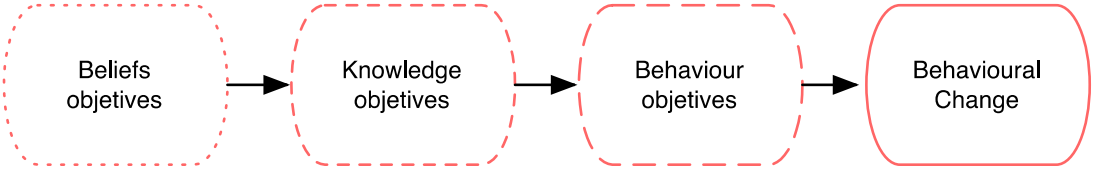


Figure 6: Belief, knowledge, and behaviour objectives

Second, the 7E model will be used within hackAIR to design hands-on tactics to elicit behavioural change. Indeed, each parameter of the model can be translated into specific actions (see also D6.1).

Engagement principle	Possible Tactics
'Enthuse'	e.g. social events
'Encourage'	e.g. photo contest with reward
'Engage'	e.g. trainings
'Enlighten'	e.g. blogposts, newsletters, factsheets
'Exemplify'	e.g. mutual learning workshops
'Enable'	e.g. technology related workshops
'Experience'	e.g. measurement day/weekend

Table 2: Possible tactics based on the 7E model

Third, the insight that change happens in stages and follows a model of diffusion will be used in hackAIR to measure the degree to which change occurs. Within hackAIR the audience is categorised into three groups, each of which consist of different types of adopters as described in the diffusion model:

1. The "show me" group consisting of innovators and early adopters: need to get information or education in order to show the desired behaviour
2. The "help me" group consisting of the early majority and late majority: demonstrate some interest in the behaviour or at least are not opposed to it. They need concrete behavioural interventions to erase the barriers towards the desired behaviour.
3. The "make me" group consisting of the laggards: are not interested at all in the behaviour and most likely will never be, unless someone forces them. Law or other means of enforcement are appropriate means here.

When considering that behaviour change occurs in stages, in different stages different groups will prevail:

Stages of change	Stage 1: pre-contemplation	Stage 2: Contemplation	Stage 3: Preparation	Stage 4: Action	Stage 5: Maintenance
Diffusion	Make Me (laggard)	Help me (late majority)	Help me (early majority)	Help me (early majority)	Show me (innovators)

Figure 7: Stages of change and diffusion

Summing up, behaviour will be attempted to change within hackAIR by targeting citizens' beliefs, knowledge and behaviour objectives. Tactics will be designed based on the 7E model. The success of the tactics will be measured through a categorisation of citizen behaviour before and after the application of the tactics.

2.4 Frameworks for behavioural change

The previous sections described the theoretical determinants of behaviour, as well as the possibilities to change behaviour. Frameworks for behavioural change are based on these theories of behaviour and models of behaviour change. Frameworks for behavioural change are thus practical and focus on the actual application of behaviour change. They can guide the design of actual interventions that should elicit behavioural change directed towards a certain target group or population, i.e. the design of a behavioural change strategy.

Within hackAIR, the Modular Behavioural Analysis Approach (MBAA) will be used as a framework. The MBAA was developed within SMIT at the Vrije Universiteit Brussel and was especially created for the implementation of behavioural change interventions in the form of survey and experiments with a digital platform basis as foreseen in hackAIR. In the following section, the MBAA is introduced. First, an overview of the framework is given. Then the different design steps are described; each step needs to be completed to implement actual behavioural change interventions.

2.4.1 The Modular Behavioural Analysis Approach (MBAA)

The Modular Behavioural Analysis Approach (MBAA) makes it possible to design behavioural change interventions in the digital era. Specifically, the model facilitates a design of behavioural change interventions not only to small scale but also to large-scale, real-life field settings that are supported by technology which provide rich real-life data. The evaluation of the results of the MBAA makes it possible to identify which interventions are worth implementing and which should not be followed or must be changed, i.e. how interventions have to be designed to actually evoke a positive behavioural change among citizens. The MBAA is displayed in Figure 8.

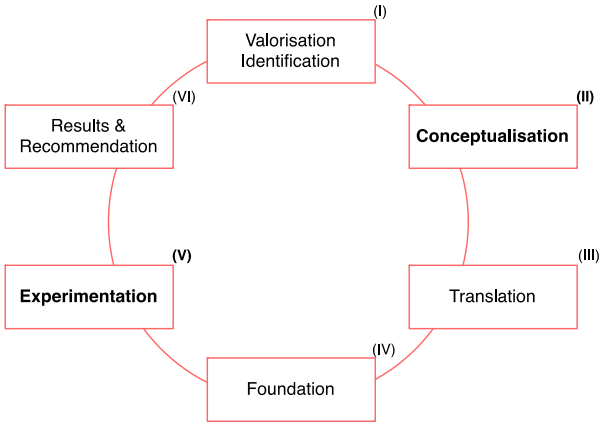


Figure 8: The Modular Behaviour Analysis Approach (MBAA)

The Modular Behavioural Analysis Approach (MBAA) entails six design steps: (I) Problem identification, (II) Conceptualisation, (III) Translation, (IV) Foundation, (V) Experimentation, and (V) Results & Recommendation. As visualised in Figure 8, this approach follows a circular logic, meaning that the results from one cycle can inform a

further iteration. Step II (Conceptualisation) and Step V (Experimentation) of the MBAA can be regarded as core tasks of the approach. For hackAIR those two steps are informed by the conceptual and empirical inquiries (Chapters 2 and 3 in this deliverable).

2.4.2 The steps within the MBAA

As alluded to above, the MBAA encompasses six design steps. In the following section, the six steps required to design a complete behavioural change strategy are described in detail. In Chapter 3, each step will be applied to the hackAIR project.

2.4.2.1 (I) Valorisation identification

The design process begins by identifying the goal of the envisioned behavioural change strategy. This would usually be either done via desk research by an individual researcher/research group, or in joint discussion/workshop with project partners as in hackAIR. This step of the MBAA identifies three different valorisation tracks: behavioural consciousness, behavioural action, and behavioural change. The complexity rises from Track 1 to Track 3; Track 1 and Track 2 provide more basic behavioural strategy approaches, which are only necessary if the topic is not sufficiently explored yet. Within hackAIR, this will not be necessary due to the conceptual and empirical inquiry in this deliverable. hackAIR will follow track 3 to design a strategy for actual behavioural change.

Track 1: Behavioural consciousness

This most basic track focuses on raising individuals' or organisations' awareness for a certain subject matter and explores their intrinsic and possible applicable extrinsic motivations.

Track 2: Behavioural action

The second possible track is concerned with the analysis of individuals' or organisations' behaviour per se, targeting volition and behavioural patterns.

Track 3: Behavioural change

The third, most complex track, concerned with the actual process of changing behaviour, explores strategies and tools to facilitate such a change as well as the problems inspiring a behavioural change.

The chosen tracks frame how the further design steps of the MBAA must be tackled and tailored to achieve the desired results.

2.4.2.2 (II) Conceptualisation

As alluded to in the introduction to this chapter, behavioural analysis is highly interdisciplinary drawing on fields as diverse as economics, and clinical and social psychology. Due to the complexity often associated with behaviour, a universal model does not exist. Hence, this step of the MBAA is concerned with the examination of the envisioned theoretical foundation, i.e. which theories of behaviour and which models of behaviour will be applied within the framework. The theories relevant for hackAIR have been discussed in the previous sections and will also inform this step.

Furthermore, in the case of experiments as foreseen in Track 3, four main strategies can be applied in order to trigger behaviour change (see Table 3). As Soman (2015) outlines, there are four main strategies for behavioural change, whose actual form might vary depending on whether they are used in the context of a market or policy implementation. A first option to change behaviour in experiments involves the restriction of existing choice. In a policy context that would mean a regulation of supply, while in a business context this measure would translate into product

unavailability. A second strategy to influence behaviour is to provide individuals with incentives. As part of a policy, these might be subsidies (positive incentive) or the imposition of taxes (negative incentive). In a market environment, the promotion or discount of products might be preferable options. Furthermore, it is possible to use the strategy of information or persuasion to elicit behavioural change. While in a policy context this would entail the disclosure of specific information, this strategy translates in the free market into advertising. The final and fourth option is nudging. This is probably the most misunderstood option of behavioural change, since it is often equated with behaviour change per se. Yet, nudging describes both in a policy and market context the influence of human's choice architecture, i.e. it entails a change of the context of the decision to implicitly steer behaviour in the desired direction.

Strategy	Example business context	Example policy context
Restricting choices	Making product unavailable	Regulating the supply of goods
Giving incentives	Having promotions and discounts	Impose taxes or introduce subsidies
Giving information	Advertising products and services	Disclose information
Nudging	Influence consumer's choice architecture	Influence citizen's choice architecture

Table 3: The four main behaviour change techniques of behaviour change

As an example, the goal of a behavioural change intervention might be to increase the consumption of sustainably caught fish by policy makers to prevent the over-fishing of the oceans. In this case, strategy one would translate into an abolition of unsustainable fishing. The second strategy would entail a subsidisation on fish that is caught in a sustainable manner. Strategy three would require disclosing information about the ocean as an ecosystem, the fish industry, and sustainable fishing practices to the consumer. Finally, the fourth strategy could entail giving fish that are caught sustainably a more prominent shelf place in supermarkets.

In the given example, all strategies could theoretically be an option; this depends on the area of interest of a project, however, some strategies might be more interesting and therefore worth exploring in practice, i.e. in the form of experiment to determine the most effective strategy. Giving an example, as suggested by Kamenica (2012) monetary rewards might not always be suitable, like in the case of inherently interesting tasks or prosocial behaviour, or it might be difficult to provide the right amount of reward and options. Also, ethical and practical reasons have to be considered e.g. in tackling sugar consumption, completely forbidding sugar to change people's sugar consumption behaviour might lead to a consumer boycott. In citizen science especially, information and incentives are used as a strategy to change behaviour and will also be used in hackAIR (see e.g. Thiel et al, 2016, Geoghegan et al., 2016).

When a strategy is chosen, several additional tactics can be chosen to carry out the strategy based on a behaviour change model such as the 7E model. Popular tactics in citizen science are included in the introduction of newsletters to distribute information or in the earning of badges as an incentive "gamification" approach).

2.4.2.3 (III) Translation

After defining the theoretical basis of the envisioned behavioural strategy, the conceptualisation should be translated into real-life scenarios. This step of the MBAA involves different tasks, namely the development of tangible objectives e.g. for surveys (Track 1 and 2) or use cases corresponding with the focus of the chosen track and the formulation of the claims (i.e. hypotheses) to be tested in experiments (Track 3). Tangible objectives can be provided as a form of a list and help to design e.g. a survey process.

Use cases for experiments are formulated from the perspective of a given user who encounters an intervention. The formulation of use cases helps to gain a better understanding of the context in which the behavioural change analysis

will take place and can aid to identify possible problems in time. Hypotheses can either take the form of "if…then" (hypotheses of difference) or the form "the higher/stronger/lower/weaker…the higher/stronger/lower/weaker" (hypotheses of correlation). The exact formulation of the investigated claims sharpens the focus of the strategy by defining the issue in detail that is investigated.

2.4.2.4 (IV) Foundation

The description of the use cases and their hypotheses makes it then possible to define the subject of investigation. Based on this, it is possible to derive what is needed to pursue the envisioned behavioural change strategy. In this step of the MBAA, the prerequisites of the strategy are outlined and organised. This entails four main aspects:

1. Technology: This refers to ensuring any required data to answer the hypotheses can be captured e.g. steps, energy use, as well as relevant context data which might influence the results such as gender, age, weather conditions etc. Accordingly, it might be necessary to either communicate with the technical team to develop an online platform, gadget or application interface, or to acquire classical wearables e.g. for monitoring steps or the heart rate.
2. Infrastructure: e.g. checking the availability of Wi-Fi, electricity or similar.
3. Participants: This refers to ensuring the access to or recruitment of a panel of participants.
4. Ethics: It is important that ethical aspects are considered in this step, especially when following Track 3 which involves an intervention in the participants' actual behaviour.

2.4.2.5 (V) Experimentation

After the foundation of the behavioural change strategy has been set, the actual empirical work can be started. Depending on the chosen valorisation track in (I), this step might differ. Pursuing research within Track 1 (Behavioural consciousness) requires the collection of in-depth personal data. Hence, qualitative interviews with open questions are often considered an ideal methodology in this track as they can facilitate the revelation of participant's intrinsic and extrinsic motivations. If knowledge about possible motivation exists, a quantitative questionnaire with multiple-choice options can also be considered. As mentioned above, motivations will be covered in the case in hackAIR through the conceptual and empirical inquiry (Chapter 3).

In the case of Track 2 (Behavioural action) quantitative questionnaires or the tracking of user behaviour via sensors are often the methods of choice. In combination, these measures can then help to reveal volition and behavioural patterns. Giving an example; a certain location, time, or data point collected via wearables such as number of steps, might trigger a question sent by an application interface, a reminder via text message or e-mail (real-time experience sampling techniques). In small settings, also open-end questions can be considered. As mentioned above, behaviour patterns will already be covered with motivations as part of the empirical inquiry (Chapter 3).

Track 3 (Behavioural change) finally entails the supreme discipline, namely experiments. The MBAA relies mainly on ICT or IoT supported experiments. They can include a large number of conditions with multiple factors and are especially valuable in testing the actual effect of behavioural interventions. These experiments will be designed for hackAIR in Chapter 4.

In detail, an experimental set-up in hackAIR entails the following tasks:

1. Base line: Identification and possibilities for setting the desired base-line behaviour, which must be the same in the whole group e.g. awareness of energy saving
2. Randomisation: Identification of the factors to be measured in each use case, namely independent variable, dependent variable, and treatment
3. Conditions: Identification of the level(s) of each factor i.e. possible variances of interventions (mediating variables), as well as influencing factors e.g. age, gender (moderating variables)
4. Set-up: Determination of the number of required units for robust results and definition of measurement period (duration of the A and B situation).
5. Trial: Assignment of the treatment to the experimental groups, and no treatment within the control group ("control design"). Data collection at point A and B as defined.
6. Results: Analysis of Variance (ANOVA) or, if a large number of variables might cause the effect and variables are continuous, regression analysis via SPSS or more advanced programmes (big data processing) to show the possible effects of the intervention

2.4.2.6 (VI) Results & recommendation

Finally, depending on the track, results can be reported and recommendations can be made. This MBAA step can entail, depending on the valorisation track chosen, different outcomes that can also inform further projects if wished. As a result of pursuing Track 1, for example, participant's motivations can be described then, measures for influencing behavioural consciousness can be proposed. For Track 2, behavioural patterns can be mapped and be better understood and measures to influence them be proposed. Hence, Track 1 and Track 2 are often used to inform Track 3 valorisation track. This is also a case in hackAIR. Track 3 makes it indeed possible to determine the impact of the examined interventions, i.e. whether behaviour could be changed. However, also this track might be wishful to iterate. Repeating Track 3 at a later point of time can also help to examine the sustainability of an intervention, i.e. whether the observed behavioural change is only a short or also long-term effect.

2.4.3 Towards a behaviour change strategy for hackAIR: Conceptual lessons learned III

From the discussion of the frameworks of behaviour change, it is possible to derive some final lessons learned for the development of a behavioural change strategy for hackAIR.

Conceptual inquiry
• *The MBAA is a framework for behaviour change that helps to practically design behavioural change strategies* • *As such, the MBAA is neither a theory of behaviour nor a model of behaviour change. Instead, theories of behaviour and models of behaviour change are used within the framework to design a strategy.*

These lessons learned have two implications for the design of a behavioural change strategy for hackAIR. First, within hackAIR the MBAA will be used to design the behavioural change strategy in practice. This means that the six steps of the MBAA will be applied in order to become aware of what is needed in terms of theoretical back up for the strategy, how exactly the strategy will be tested in experiments, what is needed to conduct these experiments, and which results

can be expected. Second, since frameworks such as the MBAA are execution frameworks and do not contain theoretical arguments; suitable theories of behaviour and models of behaviour change should be chosen depending on the envisioned objective. For hackAIR, the insights of the theories of behaviour (lessons learned I), and models of behaviour (lessons learned II) will be applied within the framework. Summing up, the MBAA will be used within hackAIR to carry out the overall design of the behavioural change strategy of hackAIR. Conceptually the strategy will be based on the previously discussed theories of behaviour and models of behaviour change.

3 Empirical inquiry: Project's best practices & user insights

This chapter examines how behavioural change for air pollution should be designed from an empirical viewpoint. Two inquiries are made. First, best practices of existing significant behaviour change projects that occurred in the past decade around air quality are extracted. The projects are mapped and the results of expert interviews with representatives of the most interesting projects are reported. Second, requirements for a behavioural change approach for hackAIR are derived. For this purpose, a survey was conducted, with subsequent results of relevance for behaviour change reported. After each section, insights are derived to develop the general empirical outline of a behavioural change approach for hackAIR. As in the conceptual inquiry, attention has been paid to the link between the engagement strategies (as reported in D6.1) and behavioural change.

3.1 Project best practices: mapping of behaviour change studies in air quality

In order to derive best practices, running and finished projects covering the topic of air pollution were investigated. Relevant projects were systematically collected, mapped, and their approach recorded. Qualitative expert interviews with representatives of the most suitable projects were then conducted. As alluded to in the introduction of this deliverable, the mapping of the projects was conducted in addition to the tasks in the initial description of work of the project (DoW). This made it possible to ensure a systematic and comprehensive approach when choosing participants for the expert interviews. Indeed, often under-documented in the scientific process, systematisation and transparency in data collection can help in reconciling limitations to qualitative research, i.e. authenticity, credibility, and reproducibility. The results of the mapping of projects and qualitative expert interviews are relevant for this deliverable as well as D6.1. Hence, in this deliverable only key information and information specific to the development of a behavioural change strategy are repeated, while a detailed account of the inquiry can be found in D6.1.

3.1.1 Methodology

In order to identify relevant projects and their representatives, three steps were taken:

1. Systematic collection of citizen science projects on the topic of air pollution;
2. Selection of projects for qualitative interview by narrowing down the initial list of projects, based on specific criteria in line with the goals of hackAIR; and
3. Qualitative expert interviews with key actors of the selected projects.

First, a systematic search within databases (Scopus), web search (Google scholar) using four search strings with specific keywords was conducted and completed alongside a snowball approach from existing peer-reviewed literature. Each paper was required to cover air pollution and citizen science. This process generated c.35 projects for analysis.

Second, projects suitable for qualitative interviews were identified. For this purpose, as criteria the projects were required to involve technology, citizen engagement, and information and communication technology (ICT). When applied, these criteria yielded six core projects for investigation. With its focus on co-creation and local level air pollution, the Cityzen project from iMinds Living Labs was added. Four of the projects included a behavioural change strategy, namely 1) EveryAware APIC, 2) Urban AirQ, 3) iSPEX, 5), and 6) ClairCity (see Figure 9).

Third, representatives from those seven projects were questioned as part of qualitative expert interviews. The interviews were conducted via Skype between March 18th and May 9th, 2017, and lasted between 45-60 minutes.

The interviews were recorded with consent from interviewees, and the transcripts were confirmed by the respondents. The transcripts were subsequently analysed with the use of qualitative analysis software MAXQDA, which helps to formulating key categories and discover overarching patterns. An overview table of all core projects can be found in the Annex of this deliverable. More specific details about the projects and respondents can be found in D6.1.

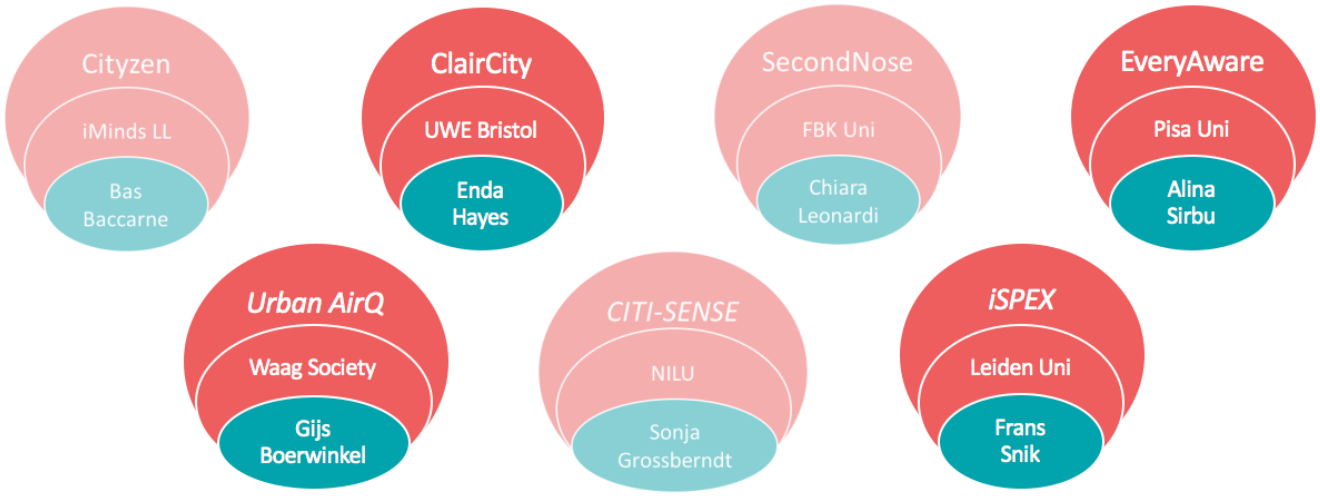


Figure 9: Projects targeting air quality and citizen science with a behavioural change strategy

3.1.2 Results

The expert interviews made it possible to derive a set of best practices regarding engagement and behaviour change. While engagement-related results are reported in D6.1, the results regarding behavioural change are reported below. The mapping of the projects mapping highlighted that, in the context of air pollution and enabling technologies, research into the relationship between user motivations and behaviour remains largely inconclusive. Although sometimes behaviour change strategies were foreseen or outlined, it was seldom a core task. A behaviour change strategy is part of the European Project Making Sense, with the Urban Air Q project representing one of the pilot cases in this larger project. This behaviour change strategy was still in the process of being defined at the time of the interview and was not ready yet. However, even so, the definition of a behavioural change strategy was not a direct consideration for success of Urban AirQ. Indeed, as the interviewee stated, behaviour change was not very relevant for Urban Air Q. It was rather assumed that the severity of the issue at the local level meant that citizens were intrinsically motivated in participating in the project.

Likewise, ClairCity is a project in progress – it started in 2016 and will run for the next 3 years. While also ClairCity has a strategy for behaviour change, their vision is more implicit than the one envisioned in hackAIR and situated on a different level. As the interviewee mentioned: "…by marrying the engagement mechanisms we mentioned, we will be developing a policy package. Within this, we'll be looking to quantify the effect of a certain policy on air quality, carbon footprint and health, and well-being of citizens in the city. There is quite a substantial quantification work package to quantify impact. What we are not doing is evaluating behaviour on an individual level, or today. This will not take the form of pre-and post- evaluation. As policy options will be implemented beyond 5 to 10 years, behaviour change will occur beyond the life time of the project. What we want to do though is put a number of things in place, so that this

process is cyclical and can be revisited at another time". Behaviour thus forms rather a starting point to segment and understand users in the ClairCity project, then a core element of the project. The behaviour research involves social practice theory and data crunching in terms of land-use planning and transport planning, as the project aims to change apportioning transport by numbers to apportioning based on behaviours.

The iSPEX project, completed in 2015, was primarily based on the broad and co-ordinated mobilisation of large numbers of citizen scientists in the Netherlands. A national campaign was developed to generate volumes of data points on days with beneficial sky coverage, which was particularly successful. In iSPEX EU, the European sister project which took place the year after, this co-ordination moved across countries and cities in Europe. Concretely, iSPEX explored aspects of behaviour in participatory sensing, and found that this was a particularly challenging variable to draw meaningful conclusions from for a number of reasons. As the interviewee stated: "We tried to measure about behaviour change and, if anything, it is marginal. People were interested to begin with, and would want to measure again if prompted. I think that the few days when measurements were conducted were not enough for any meaningful insights on behaviour. The good thing is that it began to raise awareness about air pollution, ways to measure, that this is an issue and we need to do more about it in general."

The AirProbe International Challenge (APIC) represents a multi-city competition-based campaign that utilised mobile air quality sensors to investigate participatory patterns and behaviour change across users. In parallel to air pollution as one of two thematic areas developed for the EU-Funded EveryAware project, noise pollution sensors were also developed. A web-based game was introduced and structured into three distinct phases, each with increasing amounts of information and functions available. Phase one can be considered blind mapping, where users registered perceived air pollution levels in certain areas; in phase two, users had access to pre-defined spatial areas and were encouraged to measure air pollution in this area. In phase three, all functions were available. This process was designed to test the hypothesis that increased awareness about levels of pollution would lead to a decrease in exposure to air pollution via avoidance of polluted areas. Overall, it was possible to identify some insights into specific user motivations and behaviours. Most importantly in this context, the interviews made it possible to identify enablers in behaviour for positive effects towards air quality.

It became obvious that as a problem area, air pollution does trigger in general a form of social motivation. More specifically, the identified motivations for users of air pollution sensors were incredibly diverse, ranging from curiosity, interest in contributing to science and interest in local pollution, to using data to inform policy-making and encourage new forms of governance. Indeed, behavioural research conducted as part of the EveryAware project actually found that users were drawn to high-pollution areas due to their motivation in contributing to science, and curiosity in the accuracy of the sensors (Sirbu et al., 2016). A similar atmosphere of collective contributing to science, described the interviewee of iSPEX: "In general, we had a large media presence on a national level. Everyone was talking about the measurement day, looking at weather conditions and blue sky coverage. Therefore, it felt like a national event that people wanted to be a part of. We were on the major news outlets." Interestingly, iSPEX surprised their citizens with co-authorship in a peer-reviewed article, which was published in a scientific article with the inclusion of "3187 citizen scientists" in the authorship on the first page of the paper. Hence, a collectivist approach seems to be an important trigger for behavioural change.

Across all projects, creative approaches were at the forefront of their strategies. In the context of air pollution, campaign-based approaches proved successful. Researchers in the iSPEX, EveryAware, and Urban AirQ project used gamification and reward strategies. The interviewee of iSPEX summarised their experience as follows: "In the general citizen science debate, there is a lot of discussion about whether gamification should be used. The trend seems to be indicating no – you can see this, and what I found is that some people felt 'addicted' when using iSPEX. I think that this addictive component was very important. It is a different way of operating than plugging a sensor in your garden and

not thinking about it. It is much more fun to add something that you cannot do initially." In EveryAware, different extrinsic incentives were used to try and encourage participation in different cities – one used cash, whereas others offered merchandise. Offering the sensor box to use and upgrade after the project seemed to work well. In UrbanAirQ, extrinsic motivation was not a factor in the project. The participants were purposively selected as residents of the most polluted street in the city of Amsterdam. Indeed, it has to be noted as a barrier that draws parallels with other strands of citizen science research; incentives and gamification continued to be questioned, at least as long-term solutions for all users in the context of pro-environmental behaviour (see also Geoghegan et al., 2016).

Furthermore, lessons can be drawn regarding the dynamism of motivations and behaviour. Although SecondNose did not have a behaviour change strategy in place, they were able to distil interesting lessons learned through user interactions with mobile sensors. Leonardi et al (2014) identified fundamental differences between the motivations of volunteers for initial and long-term participation in the SecondNose project. This is evident in the shift away from curiosity about the accuracy of sensors and relevance to their own habits and everyday locations, and towards the need to cross-check 'subjective sensing' with more accurate or precise readings. Summing up, behavioural change strategies as a core project task remains novel and has so far rarely been executed. Collective motives as well as gamification approaches have been proven as interesting enablers in the context of air pollution citizen science projects. Yet, time is an important barrier, since it might affect initially formed motivations. This is especially in the case of gamification critical, since gamification builds on the activation of motivations which are not directly linked to knowledge about air pollution.

3.1.3 Towards a behaviour change strategy for hackAIR: Empirical lessons learned I

On basis of the first empirical inquiry, it is possible derive some further lessons learned for the development of a behavioural change strategy for hackAIR. From the empirical inquiry into project best practices the following insights could be derived:

Empirical inquiry: Project best practices
• *Comprehensive behaviour change strategies are seldom consistently planned and executed* • *Collectivist action is an important element for changing behaviour* • *Gamification has been proven as an interesting tool, yet with some caveats.*

These lessons learned have thee implications for the design of a behavioural change strategy for hackAIR again. First, it became apparent that hackAIR will benefit from a systematically planned behavioural change strategy. This will be made possible through a systematic application of the MBAA model as described in the conceptual inquiry. Second, insights that highlight the importance of social dynamics confirm the lessons learned in previous conceptual sections, thus emphasising the need to carry out tactics in a group environment. Third, gamification is a tactic that is also identified within the conceptual part with reference to the 7E model, and seems to hold interesting potential. Hence this specific tactic should be taken up within the behaviour change strategy in hackAIR. Summing up, the empirical inquiry reaffirmed practices raised within the conceptual inquiry, which should therefore be included within the strategy.

3.2 User insights: Barriers and enablers in behaviour for positive effects towards air quality

In order to design a comprehensive behaviour change strategy for hackAIR, both existing projects and user insights were taken into account. A survey was launched for dedicated users, which helped to investigate user motivations and behaviours and identify enablers/barriers in behaviour for positive effects towards air quality. Like the results of the mapping of projects and expert interviews, the results of the survey are also relevant for both this deliverable and D6.1. Therefore, in this deliverable only key information and information specific to the development of a behavioural change strategy are repeated, while a detailed account of the inquiry can be found in D6.1.

3.2.1 Methodology

The survey process is designed for dedicated users to investigate user motivations and behaviours, and identify enablers/barriers in behaviour for positive effects towards air quality. Regarding the development of a behavioural change strategy for hackAIR, the survey process has therefore two main goals:

1. Determining participant motivations about assessing and fighting air pollution; and
2. Recording current behaviour and possibilities to change it.

The quantitative survey was officially launched on 25 June 2017. It was released via the hackAIR website and distributed with support of the project partners BUND and NILU via their respective website and social media to be able to target future active and interested hackAIR participants. The results presented in this deliverable (as well as D6.1) correspond with this audience. While a first launch within this special active group makes sense due to the inherent interest of the group in the topic, hackAIR will finally be released to a broader audience. Even though this audience might largely not be involved in the projects' pilots, their take on hackAIR is worthwhile in ensuring sustainability of the project. Thus, the survey will be iterated, targeting the broader public after a successful first launch. The results of this iteration will be likewise considered in the course of the project and inform WP7.

Overall, the survey contained 21 questions in total forming three main blocks: Questions about knowledge and awareness of air quality (8 questions), questions about perceptions of local air quality (4 questions), and questions about the design of the hackAIR platform (4 questions). Additionally, general respondents' information was recorded (4 questions), and questions promoting involvement in hackAIR was added (1 question). Besides, when accessing the survey respondents were informed about the purpose of the survey and were assured that all answers were treated anonymously and confidentially to comply with ethical considerations. The survey was available in three languages: English, German, and Norwegian. The first two main blocks are relevant for the design of the behavioural change survey and are therefore reported in this deliverable. The third main block about the hackAIR platform and the information about the user demographics are reported in detail in D6.1, towards the design of an engagement strategy and the segmentation of user. Following Lee and Kotler's (2013) approach, the survey assessed belief, knowledge and behaviour objectives determining behaviour change: Belief objectives were assessed through question Q2, Q6, and Q9; Knowledge objectives were targeted through question, Q4/Q5 (combined sorting question), Q10 and Q11 and; Behaviour objectives were inquired through Q3, Q7, Q8, and Q12. The complete questionnaire can be found in the Annex of this deliverable.

For the recruitment of participants for the behavioural change survey some extra loops and some extra time were needed as especially BUND had to discuss the compatibility of sending out a survey with their internal privacy

procedures. These sensitivities have also some impact on the development of the behavioural change strategy. It was initially envisioned to collect personalised data in the engagement and behavioural change survey. However, due to privacy concerns emerging in the course of the development of the survey (the internal privacy procedures of BUND), personal data identifying the participants (e.g. their email address) could not be directly linked to their results. Thus, it was decided to collect data on a collective rather than individual level.

3.2.2 Results

In the following, the results of the first round of the designed survey process are reported, i.e. of the pre-project survey before the launch of hackAIR. To avoid double reporting, the results discussed include hereby only the relevant results for the behavioural change strategy. Detailed demographic information about the sample (e.g. size, gender, age, education) and the engagement strategy can be found in D6.1. As alluded to above the results will inform a potential second round, aimed at a wider public.

3.2.2.1 Belief objectives

The belief objectives were assessed through question Q2, Q6, and Q9 targeting survey participant beliefs about air pollution. To begin with, it was assessed how aware the survey participants were about air pollution (See figure 10). 346 participants answered this question. More precisely, the participants were asked about their awareness regarding the causes of air pollution, the impact of air pollution, as well as regarding individual steps that they could take to actively reduce air pollution through a five-point Likert scale. It became apparent that the overwhelming majority was above average regarding awareness of the causes, impact, and individual steps to reduce air pollution, with 49.5% reporting to be quite aware and 33.8% reporting to be even extremely aware. Only 12.6% reported to be somewhat aware, while only 4.1% was either just slightly or not at all aware.

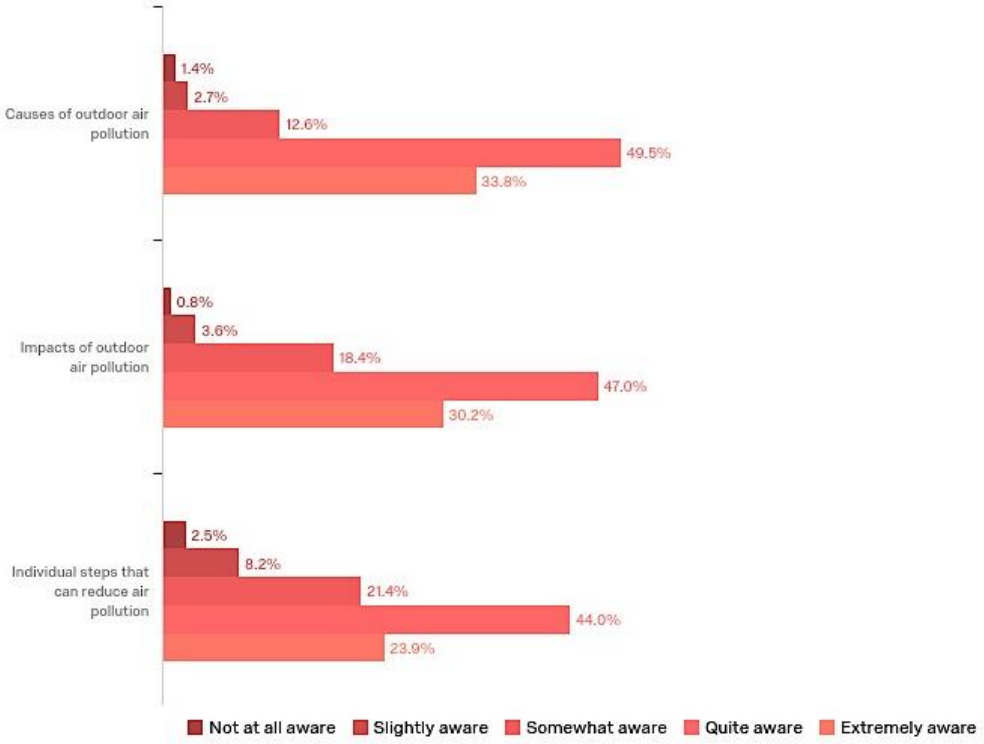


Figure 10: Awareness about the causes, impacts, and individual steps to be taken to reduce air pollution. N=346

This can be of course regarded as a result of the chosen sample, which was recruited from members of BUND and NILU. As members of environmental organisations, it is safe to assume that participants are more involved with such topics and thus more interested than the average citizen. Yet, looking at the responses regarding participants' awareness regarding causes, impacts, and steps to reduce air pollution separately, some slight differences became apparent. Most participants were most familiar with the causes of air pollution (M=4.12, on a Likert-scale ranging from 1 to 5, with 1 being not aware and 5 being very aware). Interestingly, the impacts of air pollutions were less present in the awareness of the questioned participants (M=4.02). Finally, the least awareness was apparent regarding individual steps to be taken (M=3.79). This is interesting, as the most 'passive' factor (causes) seems to have the most presence in the participant's life, while awareness about 'active' solutions seem to be less common.

Moreover, we assessed what motivates participants to inform themselves about outdoor air pollution (see Figure 11). 324 participants answered the question. Participants could choose several answers, thus providing several reasons for their motivation. The most frequently chosen answer was indeed general curiosity (55.9%), resonating the results of the questions regarding participant's general awareness regarding the causes, impacts, and individual steps to be taken to target air pollution. The next frequent chosen reasons were that the participants lived in a city or area with high pollution (42.6%) or had an existing health condition making them vulnerable towards air pollution (30.2%), showing that the awareness and curiosity of participants apparently stemmed from the feeling that they are immediately affected, which could have also been an influencing factor in their membership in environmental organisations per se.

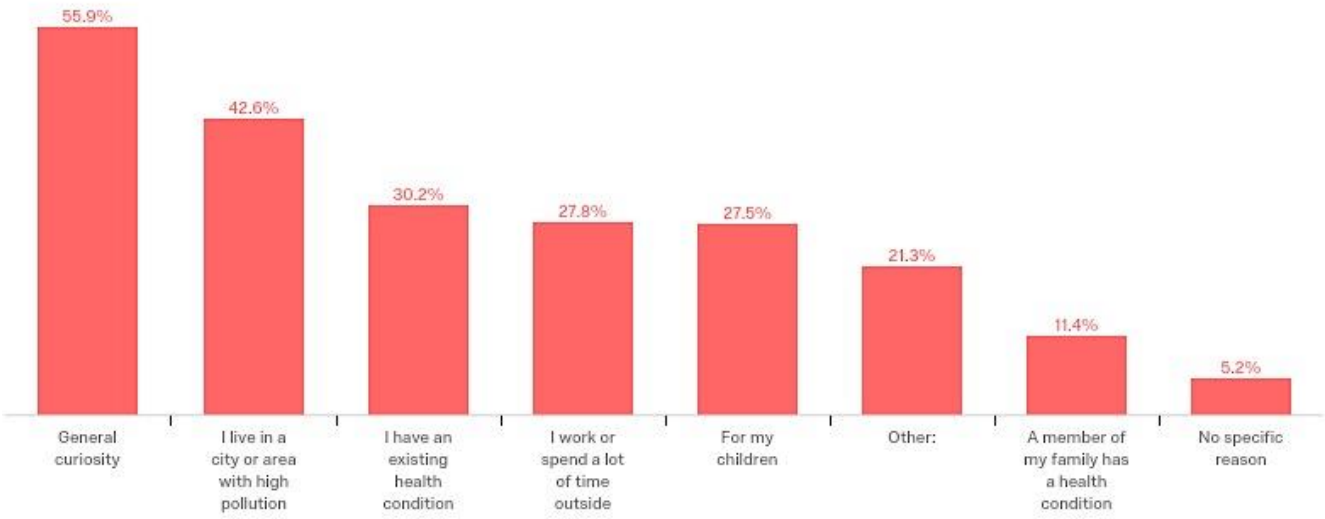


Figure 11: Motivation to inform oneself about outdoor air pollution. N=324

Other reasons revolved around people's daily life, such as a concern due to spending or working outside (27.8%) or a concern over one's children (27.5%) or related family member with a health condition (11.4%). Almost 10% of respondents also provided other reasons including example such as love for the environment and concern of the topic of health per se (e.g. "I am worried about our environment", "the well-being of all species", "the health of all of us"), the importance of making a change ("the future", "higher quality of life", "endeavour to live more sustainable"), or professional interest ("air pollution researcher"," interest in open data", "job").

Next, the survey investigated how clean the participants believed the air would be around them. 355 participants answered the question (see Figure 12). The participants could rate the cleanness using a star system, ranging from 1 star being very unclean and 5 stars very clean. In total, most participants regarded the country as a whole to be in

comparison most clean, very closely followed by the neighbourhood, and assumed the air to be most polluted on a city level.

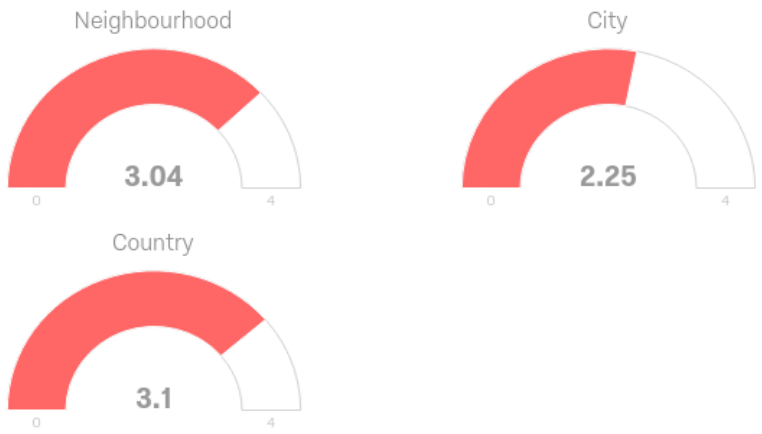


Figure 12: Rating of cleanness of air. N=355

Interestingly, when splitting the rating according to the place the participants reported to live, i.e. city, suburb or town, the results slightly varied. Participants living in cities regarded the country as a whole most clean (around 3 stars) and the city as most dirty (around 2 stars), their neighbourhood being in between (around 2.5 stars). Participants living in suburbs regarded on the contrary the air in their neighbourhood as being in comparison most clean (3.5 stars), followed by the whole country (over 3 stars), with the city being the dirtier (only 2 stars). Participants in town regarded their neighbourhood as the cleanest (3.5 stars), followed by the country (3 stars), and the city (above 2.5 stars). Finally, people living in a village regarded their neighbourhood as very clean (more than 3.5 stars), the city as being dirtiest (2 stars), and the country in between (almost 3 stars). Thus, there is general consensus amongst participants that the city is most polluted in terms of air, and their neighbourhood as cleanest (with exception of the participants living in the city regarding the country as cleaner than their neighbourhood). The highest rating came from participants living in villages or towns regarding their neighbourhood air, while the lowest rating was generally given to the city per se.

Summing up, the beliefs of the participants were reflected in the fact that they were members of environmental organisation. The majority was very aware of causes and impacts of air pollution, although awareness regarding active measures and individual steps were less common. This was reflected in general curiosity as well as the feeling of being affected as major motivations to inform oneself about air quality. Finally, it became apparent that participants usually believed their immediate environment to be the cleanest and the picture of the polluted city was prevailing.

3.2.2.2 Knowledge objectives

The knowledge objectives were assessed through, Q4 and Q5, with Q4 being a sorting question, i.e. Yes/No question, as well as Q10 and Q11 targeting the information level of the participants. To start with, the participants were asked whether they are already aware of any initiative that already aims to improve outdoor air pollution. 363 participants answered the question. Indeed, slightly more than half of all questioned participants reported being aware of an initiative (52.9%).

In the following, participants had the opportunity to report more details regarding the initiatives. Participants named a plethora of initiatives, in total more than 100. The initiatives mentioned included a range of specific projects among

the Clean Air Brussels, Open Air Cologne, Lanndeslabor, CivicLab, Ademloos, Atmosfair, Air visual, BXLair, smogalarm.org or luftdaten.org. Also, general initiatives from cities or countries were mentioned such as the Diesel ban, the ban of mud and snow spikes ("Piggdekkforbud"), environmental zones, alternative energies, trains and bus driving with green energy, driving prohibitions as in China, city fees, and car-free Sundays. Other targeted efforts were included, such as Green walls in Stuttgart, Greencity München, cycling initiatives as in cologne or Berlin, city trees, or greening of rooftops as well as a range of warning systems for smog were mentioned. Organisations named included BUND, NILU, and Greenpeace. Interestingly, most of the reported initiatives were implemented on city level (49.8%), following country (29.1%), and the regional level (15.3%); only a few projects were reported on neighbourhood level (3.9%) or individually (1%). It became apparent that the reporting of such initiatives still takes place via standard media (34.5%). Social media only ranks second (28%), followed by personal contact (15%), then websites (8.5%) or other channels (13.5%), and finally via applications directly (0.5%).

Additionally, participants were asked to rate the three main causes of outdoor air pollution in their neighbourhood. 337 participants answered the question (see Figure 13). The overwhelming majority rated traffic, including cars and cargo transportation, as the main cause of outdoor air pollution by placing it at impact factor 1 (70.3%) or 2 (20.2%). The response was followed by emissions from industry with being factor 1 at (17.2%) and main cause 2 at (30.1%). Burning from household activities such as from BBQs or woodstoves was mentioned rarely as a main factor (3.56%), but often as a second or third factor (16.6% and 19.2%). Electricity and heat production was also often mentioned as a second or third factor (14.2% and 19.5%) as well as emissions from agriculture (10.5% and 17.21%). Waste disposal and air pollution from other countries were the least mentioned causes, still scoring almost 10% and 6.5% as third factor. As further causes, ship traffic was mentioned, construction sites, air traffic, the disappearance of green areas and forests, and natural causes.

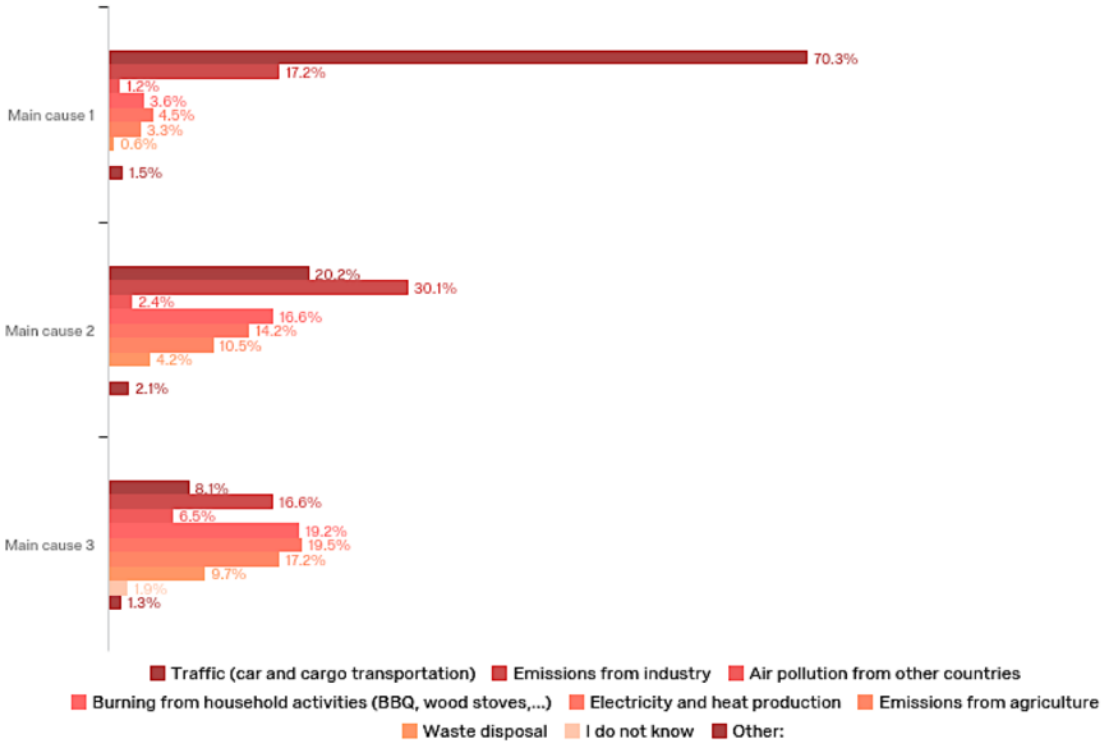


Figure 13: Rating of the causes of air pollution. N=337

Likewise, survey participants were asked about the three main effects of outdoor air pollution, which they could rank again. 340 participants answered the question (see Figure 14). The majority regarded health impacts including asthma,

skin irritation, acute respiratory diseases and cancer, as the major primary effect of air pollution (73.8%) or second (19.5%). Effects on nature, namely plants and biodiversity, were frequently chosen as a first (17.4%) or second or third option (46.2% and 18.5%). Lower quality of life was not frequently mentioned as first option (5.3%), but rather often reported as the second or third main effect (20.4% and 50.6%). These main effects were then followed by psychological issues ranked sometimes as second or third effect (9.5% and 14.8%), and unpleasant smell, and visibility loss, which were rated low percentages. Other effects were not mentioned.

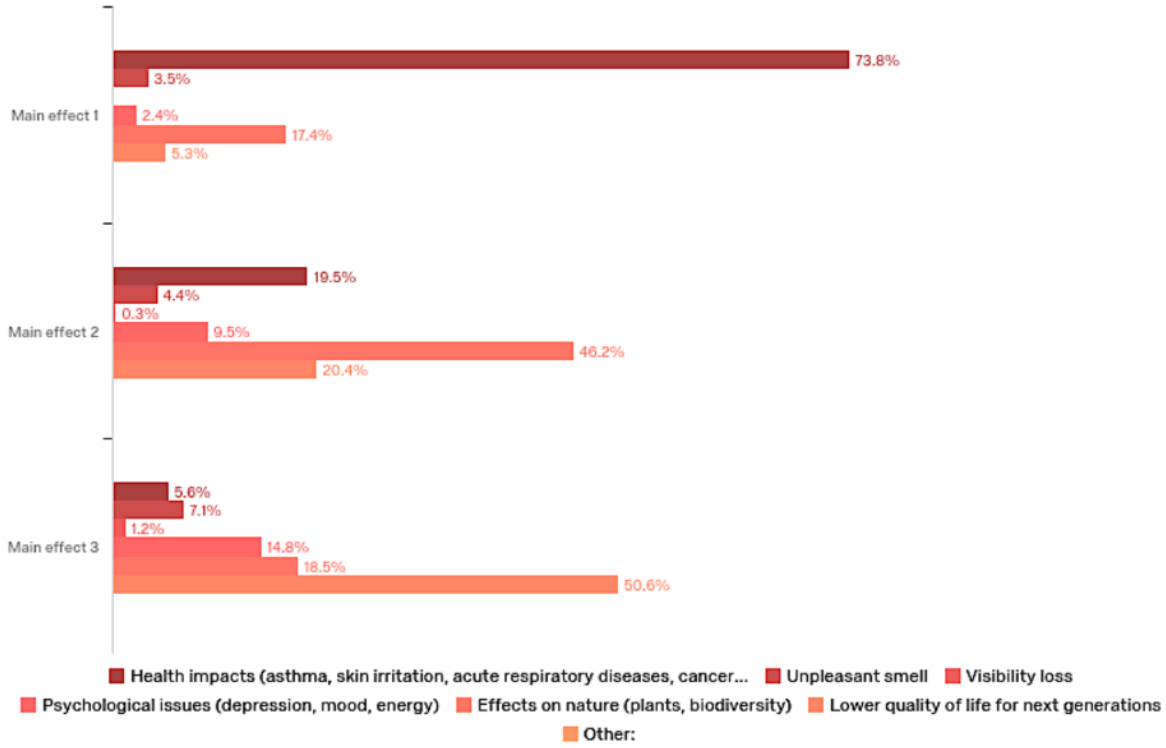


Figure 14: Rating of the impacts of air pollution. N=340

Summing up, the survey participants were knowledgeable about already existing initiatives reflecting again their background as being active members in an environmental organisation. As a main causes of air pollution, most participants regarded traffic, emissions, and burning form household activities. As main effects, health impact, effects on nature as well as lower quality of life were regarded as important.

3.2.2.3 Behaviour objectives

Finally, behaviour objectives were inquired through Q3, Q7, Q8, and Q12, which targeted the participants' current individual efforts to reduce air pollution. For this purpose, participants were first asked how they inform themselves about air pollution levels. 363 participants answered the question (see Figure 15). It can be seen that standard media remains the main source of information; 32% used channels such as TV, radio or newspapers. Standard media channels are then followed by social media at 25.5% and websites (23.4%). Other channels such as applications or personal contact play less of a role. This also echoes the earlier results about the sources of information of participants regarding specific initiatives to combat air pollution. Additionally, other sources were mentioned, among them scientific work, events or lectures, environmental organisations, or personal sensors.

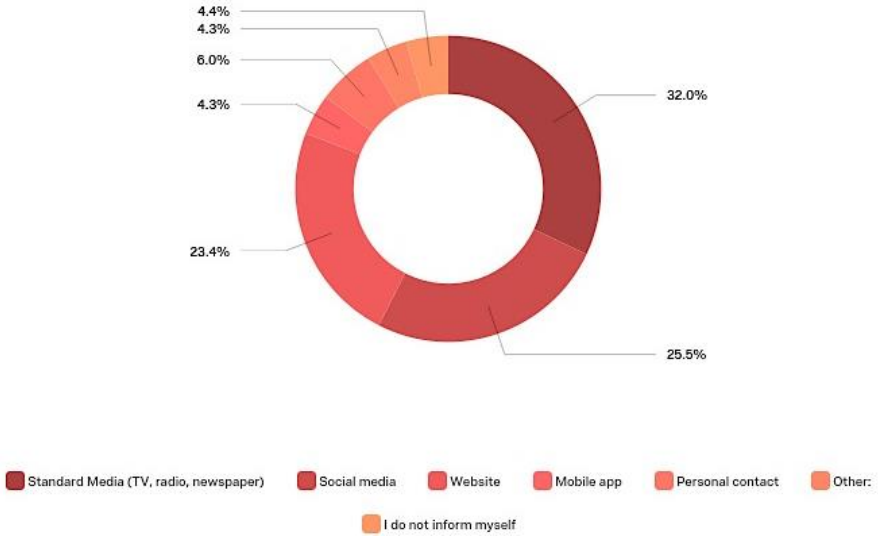


Figure 15: Information behaviour regarding air quality. N=363

Participants were asked how frequently they inform themselves about outdoor air pollution. 357 participants answered the question. It became apparent that the participants were interested in the subject matter, which can be again linked back to the sample of the survey. 36.7% reported to sometimes inform themselves while 35.7% even often inform themselves. A smaller portion of the participants informed themselves rarely (17.9%), never (4.2%) or always (5.9%). Subsequently, participants were asked to report on which occasions they inform themselves. 342 participants answered the question (see Figure 16). Again, they could select multiple answers. The most selected response was again curiosity, mirroring previous results of the survey (54.4%). This was followed again by situations with perception of direct impact – during ozone, smog or weather alerts (43.3%). Still, a fifth of the participants was informing themselves as part of their routine (33 %), while others informed themselves before outdoor activities, alone or with children (Figure 16). Yet, also many other reasons were mentioned. Among them mentioned were political events such as elections, as part of consuming media such as newspapers, as part of information sessions.

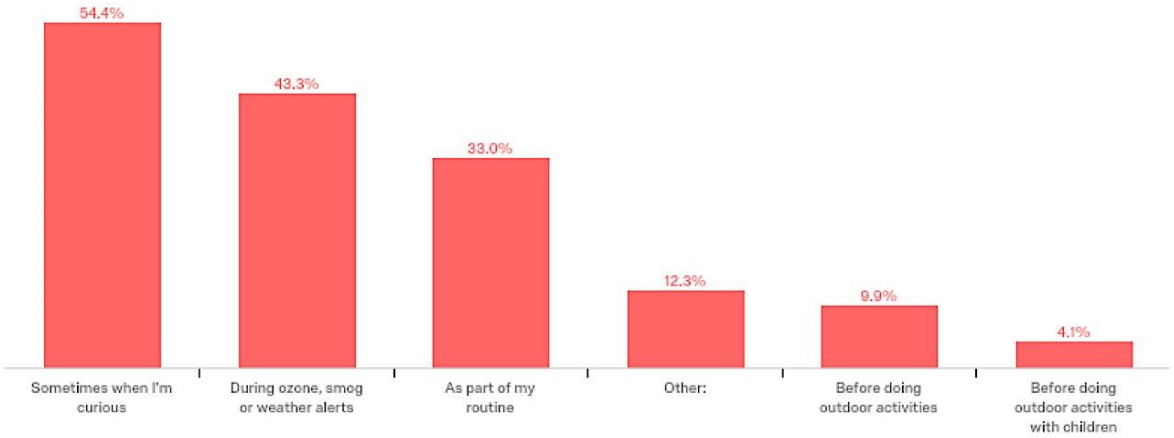
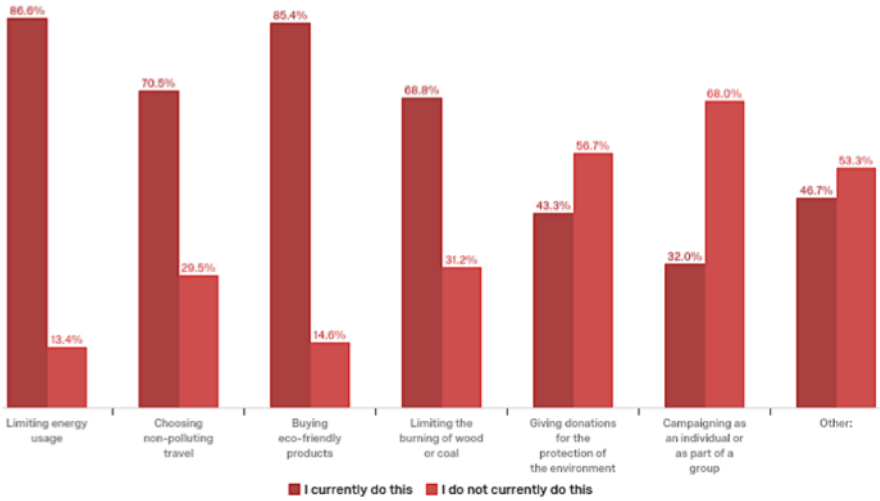


Figure 16: Occasions for information behaviour about air quality. N=342

Finally, the survey participants were asked about their current endeavours to combat air pollution (see Figure 17a). 328 participants answered the question. Most participants reported either combating air pollution by limiting energy usage (86.6%) or buying eco-friendly products (85.4%). While saving energy of course is also financially beneficial for the individual, buying eco-friendly products can be more expensive, yet, is quite easy to realise. Also common was

choosing non-polluting travel (70.5%) or trying to limit the burning of wood and coal (68.8%). A less common action was campaigning as an individual or part of a group (32%), as well as giving donations for the protection of the environment (43.3%). Of course, campaigning requires most effort of all listed activities and was thus less common, although probably more common than outside the group of members of environmental organisations. While donations are easy to make, giving straight away money to organisations was apparently not a favourite way to contribute.



Participants were then asked what they could imagine doing more. 204 participants answered the question (Figure 17b). Again, campaigning as individual or as part of a group (38.6% voted 'no') as well as giving donations (39.4% voted 'no') were no favoured options. Also, the further reduction of burning coal and wood was not favoured by many. 26.5% decided against this option. Yet, many participants could imagine limiting energy usage (7.4% voted 'no'), choosing their travel according to ecological considerations (7.2% voted 'no'), or buying even more eco-friendly products (only 2.8% voted 'no').

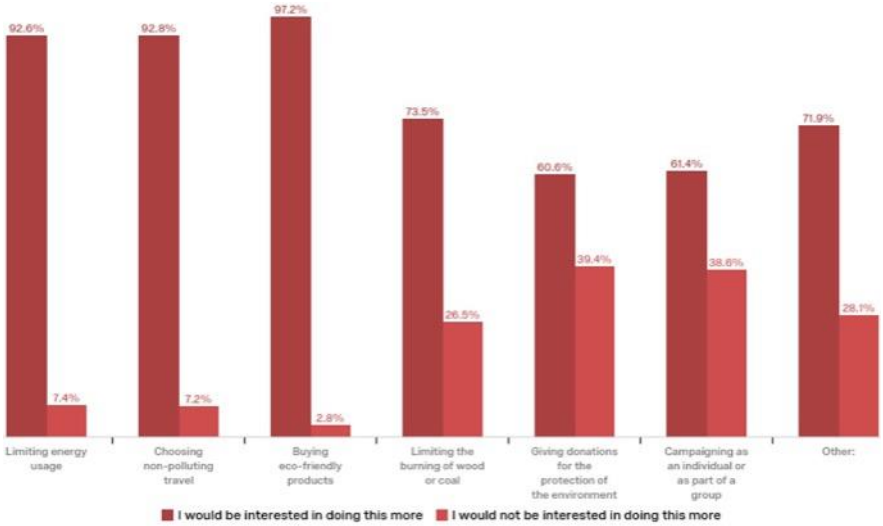


Figure 17a and 17b: Current (top) and future options (bottom) to combat air pollution. N=204

However, also many other ways of combating air pollution were mentioned. These included driving the bike, using public transport, using no car or hybrid cars or avoiding driving when possible, buying vintage clothing or less clothing, avoiding garbage, buying biological and regional food, and planting trees and plants. Summing up, most people inform themselves about air quality via standard media, followed by social media and websites. This behaviour is a carried out frequently, usually due to curiosity or in situations that affect the participants individually such as smog alerts, however routines play a role. This confirms earlier responses. Most people like to contribute through small changes in their daily life such as saving energy, buying eco-products or reducing coals and wood emissions. Active campaigning or donating money directly are less often chosen and also regarded as less desirable options.

3.2.3 Towards a behaviour change strategy for hackAIR: Conceptual lessons learned II

On basis of the second empirical inquiry, it is possible derive some further lessons learned for the development of a behavioural change strategy for hackAIR. From the empirical inquiry into user insights the following insights could be derived:

Empirical inquiry: User insights
• *The environmental background of the participants was apparent; participants were extremely or quite aware (33.8% and 49.5% respectively) of causes, impacts, and individual steps to be taken to reduce air pollution, and had also a lot of knowledge about existing initiatives. However, their awareness regarding active measures to fight air pollution was slightly less common (M=3.79 rating on a five-point scale compared to M=4.12 and 4.02 for causes and impacts)* • *Curiosity (55.9%) and the feeling of being directly affected (42.6%) are the strongest motivation and cause to seek information about air pollution* • *Standard media (32%) are the main information channels, followed by social media (25.5%)* • *Participants regarded traffic, emissions and burning from household activities as main cause (mentioned as primary cause with 70.4%, 17.2%, and 3.56%), and health impacts, effects on nature as well as lower quality of life were regarded as main effect of air pollution (mentioned with 73.8%, 19.5%, 17.4% and 5.3% as first option)* • *Participants usually believed that their country and their immediate environment is the cleanest (rated 3.04 or 3.1 on a five-point scale), while the city was generally regarded as being polluted.* • *Most people like to contribute through small changes in their daily life such as saving energy (86.6% already do this and 92.6% would like to do this more) or buying eco-products (85.4% already do this and 97.2% would like to do this more) rather than active campaigning (32% already do this and only 32.1% would like to do this more) or donating money directly (43.3% already do this and only 30.7% would like to do this more).*

Also, these lessons will directly inform the behavioural change strategy within hackAIR. First, it became apparent that it is important to consider the background of participants within hackAIR. While the survey will be extended to include more diverse groups, it became clear that the least knowledge about actual measures to fight air pollution was present. Hence, a tactic within hackAIR improving this knowledge would be decisive. Second, since curiosity and the feeling of being directly affected were important, tactics should build on these feelings. This could be achieved through gamification approaches which targets citizen's direct environment e.g. involving the feature of taking pictures of the sky to determine air pollution. Third, standard media should be used to communicate about the project, which might be especially interesting for the partners (ON:SUBJECT). Fourth and fifth, even though having an environmental background, rating the primary sources of air pollution was not always well-informed (e.g. rating traffic over other causes such as agriculture) or disguised by subjectivity as in the case of rating their immediate environment. Hence, tactics tackling the spread of information should be included. Sixth, it became apparent that tactics including smaller changes i.e. not extensive activity should be the most successful ones.

Summing up, while confirming gamification as an interesting tactics, also other tactics involving the spread of information should be tested within the behavioural change strategy for hackAIR. These should be hereby feasible and limited with regards to the action required by citizens.

4 A behavioural change strategy for the hackAIR community

This final chapter builds on the two previous chapters, i.e. the conceptual and empirical inquiry, and the lessons learned from both. It presents the conceptual and empirical design of the envisioned behavioural change strategy for the hackAIR community. As outlined in the conceptual lessons learned, the Modular Behavioural Analysis Approach (MBAA) is applied as a conceptual overall framework. Based on lessons learned, the strategy is conceptually grounded in an understanding of behaviour as being formed of deliberate, intentional and unintentional, habitual elements and emphasises the importance of social norms. Changing behaviour is regarded as a process of changing beliefs and knowledge that happens in stages and follows models of diffusion. As shown in the empirical inquiry, empirical studies emphasise the importance of gamification in breaking behaviour patterns, the significance of providing and spreading information, and the strength of collective actions.

In the following section, it is reported how the six design-steps of the MBAA is going to be applied to design and execute the behavioural change strategy for the hackAIR community. Afterwards, an outlook is given regarding tasks which still have to be completed in the context of the strategy and which will be reported at a later point, namely in D7.7 "Pilot implementation and final evaluation report: pilot performance and impact of hackAIR" (M36, Dec 2018).

4.1 Conceptual and empirical design

In the following sections the MBAA is used to design the behavioural change strategy for the hackAIR community. The steps include (I) the valorisation of the strategy, (II) its conceptualisation, (III) translation into tangible constructs and use cases, (IV) definition of the (technical) foundation needed, (V) the actual empirical measurement, and (V) a report of first results.

4.1.1 (I) Valorisation identification

As alluded to above, the goal that the behavioural change strategy wants to target has to be defined. The purpose of the behaviour change campaign in hackAIR is defined below in Table 4.

Behavioural change campaign in hackAIR	
Purpose	Creating a collective movement for monitoring air quality in a pro-active way, that leads to sustainable and pro-environment friendly behaviour and lifestyles of citizens
Focus	Citizens in Germany and Norway will be encouraged to participate in the collective sensing of air quality through the provided hackAIR application and sensors and to participate in related awareness raising activities (both online and offline), through which behavioural change will be encouraged. Behaviour change will take place on the individual level: i.e. taking actions to decrease the individual source of air pollution, taking actions to protect oneself from hazardous health effects of air pollution (more informed decision making through the provided information and data, and reduce the individual exposure to air pollution – especially for vulnerable groups), increased belief of self-efficacy, increased awareness and knowledge, etc. The actions in behaviour change will lead towards more sustainable and pro-environmental behaviour and lifestyle of citizens in the respective pilots, and will be measured through behavioural change experiments with a pre-test post-test design.

Table 4: Valorisation of hackAIR

Hence, hackAIR is aiming with its behavioural change strategy to cover the whole process of behavioural change (Track 3 in the MBAA): Behaviour change should occur in the beliefs, knowledge and behaviour of participants within hackAIR regarding air quality. The strategy will help to identify which specific interventions would be most. Specifically, the impact of different specific interventions that should trigger effective behavioural change will be tested with parts of the hackAIR community. This can be effectively carried out through a series of experiments. The strategy will thus contribute to expand the initial base camp of hackAIR users into a wide audience and foster pro-environmental behaviour (see Figure 19). Of course, the full achievement of the main target lies beyond the lifetime of the initial project.

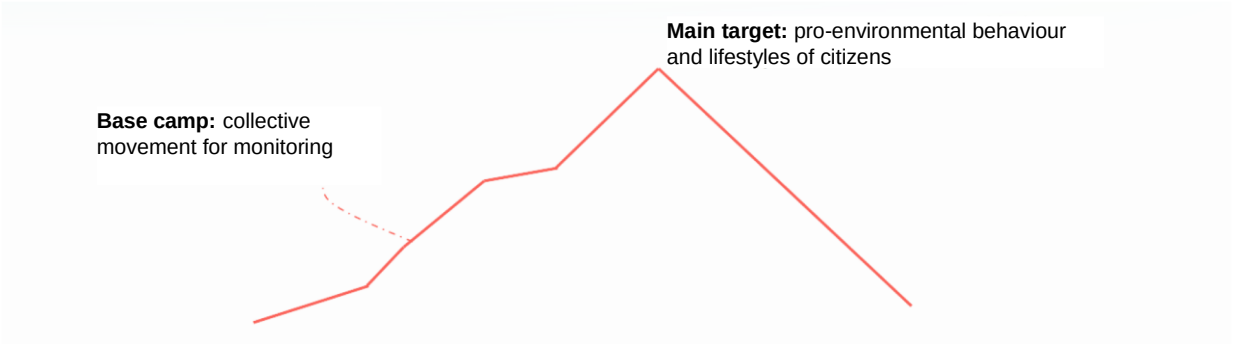


Figure 18: Target of the valorisation of hackAIR

4.1.2 (II) Conceptualisation

For the conceptualisation of the strategy it is essential to lay bare which strategies and tactics will be used, and how behaviour change will be assessed.

4.1.2.1 Strategies and tactics for behaviour change for hackAIR

For hackAIR, two of the four major strategies to change behaviour were chosen: giving information and giving incentives. The design of the specific tactics was then based on the 7E model, ensuring a link back to the engagement strategy in D6.1 that is also using the 7E model (see Table 5). As mentioned before, the 7E-framework has seven 'powers' to achieve behavioural change, being 'enthuse', 'encourage', 'engage', 'enlighten', 'exemplify', 'enable' and 'experience'. For each element, a specific tactic was chosen to be entered into practice, for which the set-up was discussed with ON:SUBJECT, the pilot or technical partners.

Strategy	7E's	Tactic
Giving incentives	'Enthuse'	Access to gamification features in on the hackAIR platform
	'Encourage'	
	'Engage'	
Giving information	'Enlighten	Receiving a "Tip of the day" via the hackAIR platform
	'Exemplify'	
	'Enable'	Collective workshops/community events about the hackAIR project
	'Experience'	

Table 5: Strategies and tactics for behaviour change

4.1.2.2 Measurement of behaviour change for hackAIR

Changing behaviour is regarded as a process of changing beliefs and knowledge. The objectives were validated during the consortium meeting in May 2017 through BUND, NILU and ON:SUBJECT. Table 6 provides a first overview of the objectives.

Objectives	
Belief	1. Increased belief of self-efficacy in taking actions to decrease the individual source of air pollution 2. Increased awareness about air pollution and its effects on health and human well-being 3. Increased awareness about individual actions they can take to contribute towards better air quality 4. Increased belief that citizen concerns will be taken into account for local policy making
Knowledge	5. Increased knowledge about the levels of air pollution they are exposed to in their daily life 6. Increased knowledge about sources of air pollutants 7. Increased knowledge about the impacts that air pollution can have on their health and well-being 8. Increased knowledge about the impact of their behaviour on air pollution 9. Increased knowledge about actions they can take to contribute to more accurate measurements 10. Increased knowledge about actions they can take to reduce the individual source of air pollution
Behaviour	11. Participate in the measurement activities of hackAIR 12. Participate in awareness raising activities of hackAIR 13. Taking actions to decrease the individual source of air pollution 14. Taking actions to protect oneself from hazardous health effects of air pollution

Table 6: Overview about all objectives within hackAIR

Behaviour change will be measured through an assessment of 'progress' regarding belief, knowledge and behaviour objectives. To facilitate this measurement, a division is being made between "basic behaviour", "medium behaviour" and "advanced behaviour", with the "advanced behaviour" representing the most developed behaviour over time. Changes in participant behaviour will be measured by assessing if a transfer from one stage to another occurred. For example, in advance of a hackAIR experiment, a citizen might have a minimum or basic level of knowledge and active behaviour avoiding air pollution. That might change after an experiment to an "advanced behaviour".

These levels of behaviour are also linking back to the categorisation of the target audience into three broad groups of 'make me' (not aware yet of the problem, not prepared to take action), 'help me' (aware of the problem, looking for how to take action) and 'show me' (express a clear interest, already aware of the problem and having taken action). Hence, for measurement, the following list of behaviours was drafted. Based on this list for each experiment a small questionnaire will be designed with 5 questions for participants to fill in before and after the experiment to measure any changes in the investigated objectives. As was the case in the already conducted opening survey, questionnaires respondents will be informed about the purpose of the survey and assured that all answers were treated anonymously and confidentially to comply with ethical considerations. The belief objectives for the hackAIR movement for monitoring air quality and pro-environmental behaviour were detailed as follows:

Belief objectives	
Basic	Have a positive opinion/feeling/attitude about the hackAIR project
Medium	Have a positive attitude towards participating in the hackAIR project for the online activities (platform and mobile application)
	Have a positive attitude towards participating in the hackAIR project for the offline activities (workshops)
	Have the belief that their participation in hackAIR will contribute to better measurements of air quality in the local neighbourhood
	Have the belief that they are able to successfully use the technological components of hackAIR (installing a sensor, download and use the application)
Advanced	Have the belief that their participation and those of others in hackAIR will contribute towards a cleaner air
	Have the belief that they will personally experience benefits from participating in hackAIR (receiving personalised recommendations and acting upon it)
	Have the belief that their actions towards a more pro-environmental behaviour are worth it
	Have the belief that monitoring and checking air quality is becoming a habit

Table 7: Specification of the belief objectives for hackAIR

Knowledge objectives	
Basic	Have information about the objectives of the hackAIR project
	Have information about air pollution in general (what are the main polluters, what are indicators of air pollution: PM versus CO_2, etc.,)
	Have information about the local case study
Medium	Have information on how to join the local hackAIR community (e.g. register with an account, download here the user guide, etc.)
	Have information about the hackAIR applications and sensors (knowing which tool is the best fit for me)
	Have information about the local air pollution level
Advanced	Have information about the actions one can take to reduce the individual source of air pollution (tip of the day)
	Have information about the causes and effects of air pollution on health and human well-being
	Have information about the legal aspects of air quality regulation in their pilot country

Table 8: Specification of the knowledge objectives for hackAIR

Behavioural objectives	
Basic	Surf to the hackAIR project website and visit pages
	Watch a video on the hackAIR project website
	Follow hackAIR on a social media account
Medium	Register to the hackAIR platform and mobile application
	Participate in the on-boarding missions of the hackAIR application

	Submit a subjective perception about the air quality
	Take a picture through the mobile application
	Participate in workshops that are technology-oriented: introduction to hackAIR platform and sensors (learning how to work with the technology)
	Install hackAIR cardboard sensors and taking a measurement
Advanced	Participate in a social event (e.g. a photo safari)
	Install a hackAIR home or mobile sensor and taking measurements
	Participate in impact-oriented workshops (discussing results, making sense of the data, discussions actions)
	Participate in mutual learning workshops with city authorities and other stakeholders for policy making
	Participate in workshops with local policy makers with the collected hackAIR data, and evoke science-policy debates
	Check regularly the personalised recommendations and tips of the day
	Obtain a badge in the hackAIR application
	Take actions to decrease the individual source of air pollution
	Take actions to protect oneself from hazardous health effects of air pollution

Table 9: Specification of the behaviour objectives for hackAIR

4.1.3 (III) Translation

Finally, the actual experimental design can be introduced. Each experiment explores the impact and thus usability of one of the chosen tactics for hackAIR. The experiments have therefore two main goals:

1. Testing possible behaviour change interventions to stimulate positive behaviour regarding air pollution
2. Identifying the most effective intervention for the hackAIR community, which can subsequently be scaled up and rolled out

Experiments are the only social science methodology able to uncover causal relationships. By manipulating an independent variable, the behaviour of a dependent variable can be observed. In particular, classical lab experiments have the advantage of high control due to precisely isolated causes and effects. The closed-test environment accounts for high internal validity. Naturally, these artificially created conditions are also the major weakness of lab experiments. In contrary, field experiments have the advantage of being able to capture real-word behaviour, acknowledge noisiness, and context. A/B-testing can hereby be carried out on a large scale; they can include a large number of conditions i.e. various factors, yet, they lack control as common within lab experiments.

Since the behaviour change strategy for hackAIR should be designed to replicate real-life contexts and the actual hackAIR user, field experiments were chosen. In order to unite the possibilities and advantages of the different set-ups, meaning scale vs. depth, the three experiments are set up with a various range of participants and either offline or online. Below, for each planned experiment a specific use case (i.e. an exemplary user story) and a hypothesis to be tested (i.e. the intervention to be measured) is listed. The specifics of how to carry out the experiments are listed under (V). As outlined under (II), within hackAIR behaviour change is defined as a change in belief, knowledge, and behaviour objectives. Therefor the following setting was chosen:

1. Belief: Changes in belief objectives were targeted through Experiment 1
2. Knowledge: Changes in knowledge objectives were targeted through Experiment 2
3. Behaviour: Changes behaviour objectives were targeted through Experiment 3

In order to have diverse settings, the experiments were carried out at different scales:

- Small-scale: Allows for a diverse set of participants, also elderlies or citizens who are not active online. This was realised in Experiment 1
- Large-scale (field experiment): Allows for a large set of participants and is carried out online. This was realised in Experiment 2.
- Large-scale (A/B testing): Allows for a large set of participants and is carried out online. Additionally, objective measures (in this case numbers of pictures) can be included. This was realised in Experiment 3.

In accordance with the project partners, at least two experiments (one being large-scale and one being small-scale) should be conducted.

4.1.3.1 Experiment I: 'Community events'

The first experiment relies on workshops to target participant's collective beliefs in fostering a change of behaviour. The workshops are small-scale, but make it possible to include a diverse group of community members, e.g. also elderlies or citizens with no internet access. The experiment can be captured in the following use case scenario:

"Fredrik lives in Norway. When he heard about hackAIR through NILU it was immediately clear for him that he wants to actively participate. Especially, he wants to build his own sensor and measure air quality not only through pictures on his phone, but with even greater precision. After becoming familiar with hackAIR sometime, he hears about workshops in which he can collectively meet up with other interest members and build his own sensor. Fredrik is delighted. He signs up for the workshop which will be executed by NILU close to his hometown. When Fredrik arrives at the workshop, he is first invited to complete a small survey, asking him about his beliefs, e.g. if he think he can make an impact. He quickly answers to the questions. In the next ninety minutes, Fredrik builds a sensor together with the other participants. They talk about hackAIR, their ability to make a contribution, and how the sensor can help them. Fredrik now feels that is indeed capable to make an impact, he is aware that he is not alone and a whole community support the goals of hackAIR. One week after the workshop, Fredrik is asked to answer another short survey, in which he reports if and how this will change his believe objectives. He is thanked for his engagements and the contribution to the hackAIR community."

Through this scenario, the following will be investigated: H1: If members of the hackAIR community participate in collective workshops helping them to improve their abilities to measure air pollution, then this will change their individual belief objectives.

4.1.3.2 Experiment II: 'Tip of the day'

This second experiment is relying on information to increase knowledge, change beliefs and thus to change behaviour. CERTH and DRAXIS focused in this context (in relation to the work done within Task 4.2) on drafting tips and messages that will be provided to users through the hackAIR app in order to provoke their behavioural change towards a more environmentally friendly lifestyle. The experiment is thus large-scale and can only include the online community. The list can be found in the Annex. This can be captured in the following use case scenario:

"Sarah participated recently in the survey distributed by BUND and NILU. During the survey, she learned about hackAIR. Enthusiastic about the goals of the project, she immediately signed up to participate. When the hackAIR website and application launched, Sarah created a profile as she wished to become active and to be more active in contributing to

combat air pollution. Shortly after she receives a short survey, asking about her current knowledge and how she can improve the air in her city with her individual behaviour. She quickly answers the questions. Sarah is informed that from now on she will receive so-called "Tips of the day". The tips should help her to grasp how she can improve her behaviour thus contributing to a clean environment. Sarah is delighted. Sarah receives the tips every day at 9h in the morning. Importantly, she is asked to keep the tips to herself in the upcoming two weeks before sharing them. Sarah tries to follow as many of the tips as possible. For example, she is more attentive regarding her use of her car. After two weeks, Sarah is asked to answer another short survey, in which she reports if and how the knowledge tips changed her knowledge objectives".

Through this scenario, the following will be investigated: H2: If members of the hackAIR community are informed via 'tips of the days' about possibilities to reduce air pollution, then this will change their individual knowledge objectives.

4.1.3.3 Experiment III: 'Gamification'

The third experiment finally uses gamification to change behaviour. This experiment links up closely with the work done in WP5, in addition to some further content in D6.1. This experiment is large scale and includes only the online community. In addition to an assessment of changing behaviour via a questionnaire, it is in this experiment possible to use the number of pictures taken per user as an additional, more objective data source to determine whether the intervention was successful (A/B testing). The experiment can be captured in the following use case scenario:

"Anna is a long-time member of BUND in Germany. She got to know about hackAIR through BUND. Anna wanted to actively participate. Especially, Anna likes to be active online. She likes the website and application for hackAIR and is enthusiastic about the possibility to contribute to cleaner air. Anna signed up and became a professional user. Shortly after she receives a short survey, asking her about her current behaviour. She quickly answers to the questions. She is informed that the number of pictures she will take will be saved. After registration Anna is now also able to earn badges for completing missions e.g. uploading pictures. The badges motivate Anna and she soon receives a high ranking within the community and participates more and more in the project. After two weeks, Anna is asked to answer another short survey, in which she reports if and how her behaviour objectives changed."

Through this scenario, the following will be investigated: H3: If members of the hackAIR community have the possibility to collect badges, then this will change their individual behaviour objectives.

4.1.4 (IV) Foundation

In order to realise the use case and to investigate case hypotheses, the following prerequisites are needed:

1. Technology: The hackAIR platform and application as already developed by the project partners. It must ensure that features such as the 'tip of the day' and the gamification elements can be released to only parts of the hackAIR community for some time. Also, it has to be possible to send short questionnaire to the user when registering for the platform an after taking part in an experiment.
2. Infrastructure: The ability to access the hackAIR platform either online or through a smartphone are defined as preconditions.

3. Participants: Participants are recruited among the members of the hackAIR community.
4. Ethics: A positive stimulus is given i.e. a motivation to contribute to the increase of air quality. While some features are in the beginning exclusively released to certain groups, after some time the supposedly advantageous features will be available to the whole community.

4.1.5 (V) Experimentation

Based on the use cases and hypotheses developed under (III), in the following it is specified how the experiments will be carried out. All experiments have a 'before-and-after' experimental design.

Experiment 1 ('Community events'), will be set-up on a small scale, i.e. in the context of workshops launched by the pilot partners and targets participant belief objectives		
Measurement	*What?*	Changes in **belief objectives** after participation in a **workshop**
	How?	All participants answer the same questionnaire with 5 questions assessing the level of **belief objectives** (basic, medium advanced) at point A and B. Possible changes in those objectives indicate behaviour change (see (II) for details).
	When?	When registering to the workshop (Measurement A), then **1 week** after the workshop (Measurement B)
Participants	*Who?*	To make sure a behaviour change occurs due to workshop (the 'intervention'), the same measurement will be carried out among participants who do not participate in the workshop at this point (**control group**), and participants who participate (**experimental group**).
	How many?	**60** citizens per pilot partner should participate: **30** in the experimental group (workshop) and **30** in the control group (no workshop, but are also assessed with the questionnaire). This number can be reached through several workshops about the same topic at a pilot location, e.g. 3 workshops with around 10 participants. It is important to have participants with a diverse background (e.g. elderlies, offline community)
Interpretation of behaviour change	*How?*	Linking back the levels of behaviour (basic, medium, advanced) to the categorisation of the target audience into **three broad groups** of 'make me' (not aware yet of problem, not prepared to take action), 'help me' (aware of problem, looking for how to take action) and 'make me' (express a clear interest, already aware of problem and having taken action) (see (II) for details). The experiments will help to define whether the intervention helps participants to move between groups.

Table 10: Experiment 1: Community events

Experiment 2 ('Tip of the day') is set-up as large-scale field experiment targeting the whole hackAIR community online and targets participant knowledge objectives		
Measurement	*What?*	Changes in **knowledge objectives** after receiving **'tips of the day'**
	How?	All participants answer the same questionnaire with 5 questions assessing the level of **knowledge objectives** (basic, medium advanced) at point A and B. Possible changes in those objectives indicate behaviour change (see (II) for details)

	When?	When registering to the hackAIR platform (Measurement A), then after a **2-week** period (Measurement B)
Participants	*Who?*	To make sure a behaviour change occurs due to the 'tips of the day' (the 'intervention'), the same measurement will be carried out among participants who do not receive 'tips of the day' (**control group**), and participants who receive 'tips of the day' (**experimental group**).
	How many?	**200** citizens per pilot partner should participate. **100** in the experimental group ('tips of the day') and **100** in the control group (no 'tips of the day', but are also assessed with the questionnaire). The experiment will take place online only.
Interpretation of behaviour change	*How?*	Linking back the levels of behaviour (basic, medium, advanced) to the categorisation of the target audience into **three broad groups** of 'make me' (not aware yet of problem, not prepared to take action), 'help me' (aware of problem) and 'make me' (express a clear interest, already aware of problem and having taken action) (see (II) for details). The experiments will help to define whether the intervention helps participants to move between groups.

Table 11: Experiment 2: Tip of the day

Experiment 3 ('Gamification') is set up on the same large scale as well and is online based. Additionally, it is set up A/B testing making it possible to include more objective measures (count of pictures) next to the classical assessment via questionnaires.		
Measurement	*What?*	Changes in **behaviour objectives** after having access to **gamification features**
	How?	All participants answer the same questionnaire with 5 questions assessing the level of **behaviour objectives** (basic, medium advanced) at point A and B. Possible changes in those objectives indicate behaviour change (see (II) for details). Additionally, participant behaviour will be assessed based on the **number of pictures uploaded.**
	When?	When registering to the hackAIR platform (Measurement A), then after a **2-week** period (Measurement B)
Participants	*Who?*	To make sure a behaviour change occurs due to gamification (the 'intervention'), the same measurement will be carried out among participants who have no access to gamification features (**control group**), and participants who have access to gamification features (**experimental group**).
	How many?	**200** citizens per pilot partner should participate. **100** in the experimental group (gamification) and **100** in the control group (no gamification, but are also assessed with the questionnaire). The experiment will take place online only.
Interpretation of behaviour change	*How?*	Linking back the levels of behaviour (basic, medium, advanced) to the categorisation of the target audience into **three broad groups** of 'make me' (not aware yet of problem, not prepared to take action), 'help me' (aware of problem) and 'make me' (express a clear interest, already aware of problem and having taken action) (see (II) for details). The experiments will help to define whether the intervention helps participants to move between groups.

Table 12: Experiment 3: Gamification

In order to explore further the sustainability of each experiment, in the aftermath of the experiments focus group interviews will be carried out and co-creation sessions will be held with selected core users. As mentioned in the introduction to this deliverable, while these measures have been foreseen initially at an earlier point, conducting those interviews and sessions after the launch of the hackAIR project after the interventions have been successfully applied

provides richer results. Participants will be able to reflect actual real-fife experiences with the project per se and the experience intervention in specific.

4.1.6 (VI) Results & recommendation

The actual implementation and execution of the developed experiments will take place at a later stage of the project, namely as part of WP7 "Pilot operation and evaluation". Hence, the final results of this behavioural change strategy will be reported in D7.7 "Pilot implementation and final evaluation report: pilot performance and impact of hackAIR" (M36, Dec 2018). The following table provides an overview of the general planning and details which actions related to the behavioural change strategy will be carried out. Corrective actions might be considered if necessary.

	I-Pre-test	II-Platform launch and test	III-Full pilot	IV-Full pilot expansion	V-Evaluation and integration
Time frame	November 2016-August 2017	September-October 2017	November 2017-March 2018	April-October 2018	November-December 2018
Overall project aim	Test hackAIR home sensor Test hackAIR mobile sensor Test mobile app	Test hackAIR platform including mobile app, sensors, and data communication etc.	Pilot full implementation	Pilot expansion	Pilot reporting, integration and evaluation
Overall behaviour change strategy	Development of the behavioural change strategy		Preparation of the implementation the behavioural change strategy	Implementation of the behavioural change strategy Intermediate evaluation via focus groups and co-creation sessions	Evaluation of the behavioural change strategy
Survey	Launch of the pre-project survey (1st iteration) and analysis	Expansion of the survey (2nd iteration) and analysis			
Experiments		Testing of the technical requirements for the experiments (surveys, tips, gamification)	User recruitment for experiments and start of experiment I	If necessary completion of experiment I, start of experiment II and III	Analysis and determination of most effective intervention, follow up co-creation workshops and focus groups

Table 13: Planning and milestones

5 Conclusion

This deliverable (D6.2) reported on the second task within WP6. It aimed to design a behavioural change strategy for the hackAIR project. With the help of the strategy, the effectiveness of behavioural change techniques for users who have successfully been engaged into using the hackAIR platform will be tested. As an expected result, it is assumed that citizen's behaviour towards fighting air pollution should be positively affected.

The deliverable started by addressing behavioural change through a conceptual inquiry. A literature review about theories describing human behaviour (expectancy value theory (EVT), theory of planned behaviour (TPB), and theory of interpersonal behaviour (TIB)), models used to assess behavioural change (social marketing theories, especially the 7E model, stages of changes theory, and diffusion theory), and frameworks for designing behavioural strategies (modular behavioural analysis approach (MBAA)) was conducted. From the review of the theories of behaviour, it was concluded for hackAIR that given the intentional and unintentional aspects of behaviour, citizens should be asked about both specific and routine behaviours when assessing behaviour for hackAIR. It was outlined that due to the decisiveness of social norms, the behavioural change strategy of hackAIR should explore behavioural change not only in isolated environments e.g. in front of a smartphone screen, but also in interactive group settings, such as workshops. From the models of behaviour change, it was derived that behaviour would be attempted to be changed within hackAIR by targeting citizens' beliefs, knowledge and behaviour objectives, and that behavioural change tactics would be designed based on the 7E model. Tactics would then be measured through a categorisation of citizens' behaviour before and after application, based on the stages of change model and models of diffusion. The MBAA framework, a practical step-guide for establishing behavioural change strategies, was chosen to design the strategy.

As a next step, behavioural change was addressed through an empirical inquiry, both by learning from a mapping of existing projects that were conducted in the past decade around air quality and by interviews with experts from those projects, as well as user insights gained in a survey. From the project mapping, it could be confirmed that hackAIR would benefit from a systematically planned behavioural change strategy based on carefully chosen theories, models and a systematic framework as attempted in the conceptual inquiry. Insights from the user survey confirmed gamification as an interesting tactic. Additionally, the survey suggested testing other tactics involving: 1) the spread of information within the behavioural change strategy for hackAIR and 2) maintaining a focus on feasibility with regards to the action required by citizens.

Finally, the insights of the conceptual and empirical investigation were combined, and were used to inform the development of a behavioural change strategy for the hackAIR community. The impact of possible interventions for behavioural change will be investigated in three experiments within the behavioural change strategy for hackAIR. The experiments will address the generation of social collectivism through offline community events (experiment 1), providing information via 'tips of the day' online (experiment 2), and gamification on the hackAIR platform online (experiment 3). The next step will be to carry out and test the designed interventions. While a tentative planning was laid out in this deliverable, a meeting with all project partners in October in Amsterdam will help to further refine the strategy and detail the suggested timeline.

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Annexes

Annex 1: Further information about the project mapping

Project	ICT?	Technology	Behavioural change strategy?	Project Status
Urban AirQ	x	DIY (?) Sensor, Real Time data platform	x	Ongoing
Citi-Sense	x	Monitoring toolkit, web & mobile application	-	Complete (2012 - 2016)
SecondNose	x	Mobile CO & No sensor, Web and Mobile application	-	Complete (2015)
EveryAware APIC	x	Black Carbon Sensor, Web-based game, Web-data portal, Mobile Application	x	Complete (2010 - 2014)
ClairCity	x	Mobile Application, Web Game	x	Ongoing (2016 - 2020)
iSPEX	x	Attachable iSPEX, Web and Mobile Application	x	Complete (2015)

Annex 2: Survey questions

Q1 Thank you for agreeing to take part in our survey. We would like to find out more about your perspective and opinion on outdoor air pollution. Your personal experience is important, thus there are no wrong or right answers. Do not reflect extensively, but answer spontaneously. This survey is expected to only take a few minutes to fill in. All answers are treated anonymously and confidentially. Please click the red button below to begin.

Q2 How aware are you about causes and impacts of outdoor air pollution? (Not at all aware, slightly aware, somewhat aware, quite aware, extremely aware)

- Causes of outdoor air pollution
- Impacts of outdoor air pollution
- Individual steps that can reduce air pollution

Q3 How do you inform yourself about outdoor air pollution levels? (Select all that apply)

- Standard Media (TV, radio, newspaper) (1)
- Social media (2)
- Website (3)
- Mobile app (4)
- Personal contact (5)
- Other: (6) _____
- I do not inform myself (7)

Q4 Are you aware of any initiative that already aims to improve outdoor air pollution? (yes, no)

Q5 If Are you aware of any initiative that already aims to improve outdoor air pollution, lease tell us more about at least one of these initiatives. If you do not remember the details, just continue the survey.

- What is the name of this initiative? _____
- Which level did this initiative take place on? (Individual, neighbourhood, citywide, regional, nationwide, I do not know)
- How did you first find out about it? (Standard media, social media, website, mobile app, personal contact, other)

Q6 What motivates you to inform yourself about outdoor air pollution? (Select all that apply)

- General curiosity (1)
- I work or spend a lot of time outside (2)
- I have an existing health condition (3)
- A member of my family has a health condition (4)
- For my children (5)
- I live in a city or area with high pollution (6)
- Other: (7) _____
- No specific reason (8)

Q7 How often do you inform yourself about outdoor air pollution?

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Always (5)
(1)	•	•	•	•	•

Q8 On which occasions do you inform yourself about outdoor air pollution? (Select all that apply)

- Before doing outdoor activities (1)
- Before doing outdoor activities with children (2)
- As part of my routine (3)
- Sometimes when I'm curious (4)
- During ozone, smog or weather alerts (5)
- Other: (6) _____

Q9 How clean do you think the air is around you? (1 star = very unclean, 5 stars = very clean)
_____ Neighbourhood (1)

_____ City (2)

_____ Country (3)

Q10 In your eyes, what are the three main causes of outdoor air pollution in your surrounding area?
Main causes: Traffic, emissions from industry, air pollution from other countries, burning from household activities, electricity production, emissions from agriculture, waste disposal, I do not know, Other _____

Q11 In your eyes, what are the three main effects of outdoor air pollution?
Main impacts: Health impacts, unpleasant smell, visibility loss, psychological issues, effects on nature, lower quality of life, I do not know, other _____

Q12 How do you currently combat outdoor air pollution? (Please fill in both columns)

	I currently do this		I would be interested in doing this more	
	Yes (1)	No (2)	Yes (1)	No (2)
Limiting energy usage (1)	•	•	•	•
Choosing non-polluting travel (2)	•	•	•	•
Buying eco-friendly products (3)	•	•	•	•
Limiting the burning of wood or coal (4)	•	•	•	•
Giving donations for the protection of the environment (5)	•	•	•	•
Campaigning as an individual or as part of a group (6)	•	•	•	•
Other: (7)	•	•	•	•

Q13 hackAIR will have an internet website and mobile application. Below are some features that we are working on - which of these features appeal to you? (Select all that apply)

- Viewing Real-time information about air pollution around me (1)
- Receiving information to decrease my own contribution (2)
- Allowing me to measure air pollution around me (3)
- Sharing my measurements and experiences with others (4)
- Sharing my concerns with other people (5)
- Sharing my concerns with policy makers (6)
- Other: (7) _____

Q13a You said you would like to measure air pollution around you. If these options were possible, how would you like to do this? (Select all that apply)

- Taking Photos of the sky on a smartphone (1)
- With an electronic, self-built sensor (2)
- With a simple (non-electronic), self-built sensor (3)

Q14 Which tools or activities would help you stay motivated to be part of hackAIR? (Select all that apply)

- Collecting badges in a smartphone app (e.g if you complete a task) (1)
- Social events (e.g. meet & greets) (2)
- Photo contest (3)
- Workshops with other users (e.g. learning about building sensors) (4)
- Workshops for policy making (5)
- Access and info on other relevant projects (6)
- Feedback on your contribution from experts (7)
- Other: (8) _____

Q15 Which main barriers do you think might prevent you from participating in an initiative like hackAIR? (Select all that apply)

- Time constraints (1)
- Lacking information about the project (2)
- Not enough knowledge on air quality monitoring (3)
- Family members won't approve of participation (4)
- No belief in the goals of the initiative (5)
- Concern about the technical skills to become involved (6)
- Not enough knowledge on air quality (7)
- Other: (8) _____

Q16 How old are you?

	Under 15 (1)	15-20 (2)	21-30 (3)	31 - 40 (4)	41 - 50 (5)	51 - 60 (6)	61-70 (7)	70+ (8)
Age in years (1)	•	•	•	•	•	•	•	•

Q17 What is your highest level of education?

	Less than secondary school (1)	Secondary school (2)	Bachelor degree (3)	Masters Degree (4)	Doctoral degree or higher (5)	Professional degree (6)	Other (7)
Level of education (1)	•	•	•	•	•	•	•

Q18 Where do you live?

- I live in a city (1)
- I live in the suburbs of a city (2)
- I live in a town (3)
- I live in a village (4)
- Other (please specify) (5) _____

Q18a You selected that you live in a city, town or village. Please provide the name: _____

Q19 In the next few months, hackAIR will be tested and further developed. How would you like to stay involved?

- I would like to be involved with hackAIR directly in the future (1)
- I would like to be involved in hackAIR through my local partner in the future (2)
- I would not like to be involved in the future (3)

Annex 3: 'Tips of the day'

1. You could reduce emitted air pollutants if moving by public transport.
2. Want to ride your bicycle? It's not only fun and great exercise; you'll also help to keep the air beautifully clean.
3. Time for a walk? Sweet! Air quality becomes so much better when more people leave their cars at home.
4. Transportation accounts for about 23% of greenhouse gas emissions in Europe. Think about the way you travel in your city!
5. Have you heard of carpool karaoke? What a perfect way to get to work - while keeping the ambient air breathable.
6. Driving slowly on unpaved roads can prevent vehicles from emitting dust.
7. Are you a driver? Did you know that you can reduce your contribution to air pollution by switching off your car motor when idling for more than 20 seconds?
8. To warm up your car, drive slowly the first 5km instead of run. Gentle ride means gentle pollution!
9. Keep your car engine in good condition by performing the regular maintenance.
10. Aggressive driving produces up to five times more toxic emissions than normal!
11. Drive within the speed limits. It works well for both your safety and the environment!
12. Prefer to use energy efficient appliances. This saves you money and it's good for the environment.
13. Keep your water heater at 50°C, and use cold water whenever possible.
14. Switch off the lights when you are not in the room. The room is not afraid of the dark…
15. Unplug electronic devices when not in use. They'll thank you later!
16. Fans are a climate friendly and easy alternative to air conditioners!
17. Did you know that indoor fireplaces are a huge source of indoor air pollution? Limit wood burning.
18. If you have to burn wood in your home, follow useful precautions to reduce pollution.
19. Don't burn wood that is painted. It won't colour the steam, only produce more toxic pollution.
20. Avoid the use of spray products. That smells of... CO2.
21. Manual garden tools are a low-cost alternative to those that run on gasoline. Approved by flowers of all kind!
22. Did you know that a family of four members is responsible for releasing 20 tons of greenhouse gases into the atmosphere each year?
23. Energy consumption in home is the 3rd source of air pollution production: close heating vents and doors to rooms that you are not using.
24. Hang clothes out in order to dry instead of using a dryer.
25. Whoa, what's that smoke? If you like making a fire in your garden, make sure the wood you use is untreated and dry - your lungs will thank you.
26. Did you know that trees and plants naturally purify the air? Indoor greenery, a few pots on the balcony or a small garden can help you breathe deep.
27. Use natural soy or beeswax candles instead of petroleum/paraffin-based candles.
28. Avoid BBQ when air pollution levels are high. Steak can wait; planet cannot!
29. Recycle as much as you can! Buy products that do not have a lot of packing and that can be recycled.
30. Exercising outdoors early in the morning is a great way to avoid rush-hour air pollution.
31. Use video conferencing for business meetings, when possible, in order to avoid unnecessary travel.
32. Use the hackAIR app to detect and avoid air pollution hotspots!

33. Avoid burning organic waste or garden leftovers. Prefer to compost them!
34. Eat many fresh fruits and vegetables. They help maintain your body's antioxidant reserves which are able to reduce the effects of air pollution.
35. Keep windows closed when outdoor air pollution is high; this way you won't burden the indoor atmosphere.
36. If cooking with gas, use an extractor fan with a filter.
37. Did you know that your exposure to harmful air pollution is greatly increased on main roads with a lot of traffic? If possible, prefer to use secondary roads.
38. If you commute into the city, think about leaving your car at park & ride spots; that way you take away your share from inner city pollution.