



# Co-creating Artificial Intelligence: Designing and Enhancing Democratic AI Solutions Through Citizen Science

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## ABSTRACT

Although artificial intelligence (AI) is omnipresent in our everyday lives, the level of awareness and knowledge among the general population remains mixed. The lack of understanding is particularly prevalent among older adults, and people with a low education and income. To bridge this knowledge gap and to empower individuals to become informed AI users, further outreach and awareness raising is necessary. This article presents a case study in Flanders (Belgium), called the amai! program (Flemish slang for “oh my!”). The program invites participants to voice their ideas or societal problems they wish to solve through AI and to be involved in the development of citizen-driven research projects. Using a citizen science (CS) approach, ideas are collected through a centralized platform and eventually realized through an open project call with partners from industry, civil society, and research institutions. As a result, 988 ideas have been submitted through the program’s platform and 14 are being realized in the domains of mobility, climate, health, and work. Here, we outline a phase-based approach for setting up citizen-driven research projects, as well as lessons learned on how to sensitize and activate citizens. Guidelines are also provided on how to involve participants to become aware and learn about science and technology, especially those with no prior knowledge or interest. Overall, this case study demonstrates how AI innovation and governance can be democratized through citizen participation and can build capacities in a fun and accessible way.

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## INTRODUCTION

Artificial intelligence (AI) is becoming more widespread in our everyday lives, but many people use it without realizing it (Kennedy, Tyson, and Saks 2023; Supplemental File 1: Appendix A). Whether in navigation systems, chatbots, music recommendation systems, etc., laymen find it difficult to understand the role of AI in these systems' functioning. This lack of understanding is particularly prevalent among individuals with lower levels of education and income (Kennedy, Tyson, and Saks 2023), and in older adults (ONS 2023). AI is often misunderstood in public discourse due to the lack of a single definition and the wide range of technologies used in different contexts. In line with De Ketelaere (2020), this article chooses an encompassing definition of AI and defines it as “computer systems that independently can learn, decide upon, and perform decisions” (De Ketelaere 2020, p.15).

Although the general population lacks awareness about AI, attitudes seem to vary from very positive to pessimistic. According to the Eurobarometer (special edition 516), most respondents believe that AI will have a positive impact on our lives in the next 20 years (European Commission Directorate General for Communication 2021). Demographic trends show that males and the young, active population living in urban areas are more likely to think there will be a positive impact. Examples of perceived benefits are improved access to healthcare, increased access to education and learning (ONS 2023), having more time, and performing less dangerous and repetitive jobs (Supplemental File 1: Appendix A). Another study, with 4,006 European citizens from eight different countries, revealed that self-assessed knowledge about AI is rather low, although attitudes are very positive (Scantamburlo et al. 2023). We argue that this divide between knowledge and approval can be due to fictional or utopian narratives that might create confusion and contribute to creating high or overestimated expectations about AI. In this respect, Sartori and Bocca (2023) explore how people reacted towards different scenarios of hopes and fears associated with AI and robots. Their data supports a misalignment between what AI is and what people think it ought to be, with people believing that pessimistic scenarios are more likely to become reality.

Overall, people seem to be worried about job displacement (Holder, Khurana, and Watts 2018), automation, and the loss of human decision-making (Khogali and Mekid 2023), privacy and surveillance issues (Müller 2020), biases in underlying algorithms and datasets (Righetti, Madhavan, and Chatila 2019), and other such concerns. A five-country study by Gillespie et al. (2021) revealed that respondents have low trust towards AI systems, with trust being a

central driver of AI acceptance. Hereby, familiarity with the technology, that is, understanding how and when it is used and having knowledge about common applications, is a strong predictor of trust and acceptance of AI systems. Another fear is that algorithms and intelligent machines may not provide equal benefits to all. Similar to the Internet, an “algorithmic divide” might create a gap between the technology haves and have-nots, with a disproportionate impact on vulnerable groups (Yu 2020). Although it is not necessary for people to comprehend how algorithms work, understanding the disadvantages and advantages of algorithm-enhanced technologies can help people to make informed decisions and safeguard their privacy and other individual rights.

Because these perceived harms and potential threats are increasingly recognized, the importance of developing and utilizing AI in accordance with fundamental rights, the rule of law, and democracy is becoming more widely acknowledged. Therefore, researchers and policy makers are advocating to democratize AI, to make sure that positive impacts are maximized for all. The democratization of AI can refer to a variety of goals and purposes, amongst others the democratization of AI use, development, profits, and governance (Seger 2023). Our focus is on the democratization of AI development and AI governance. The former refers to the involvement of a wider range of people in AI design and development processes, through, for instance, providing open access to AI models or by investing in educational and upskilling opportunities, whereas the latter refers to the influence of a wider community of stakeholders about the “if, how, and by whom AI should be used, developed and shared” (Seger 2023, p.6). Put into practice, the amai! program supports and facilitates participatory processes through citizen science (CS) from a cross-disciplinary perspective. Through the program, citizens are engaged in organising the participatory aspects of research projects, combined with access to science information about AI technology in a playful and understandable format. A large-scale participation initiative is being set up to gather inputs from diverse target groups about their societal concerns and needs, which could be solved through AI technologies.

Our primary aim herein is to outline the democratic processes of the amai! program, and to provide guidelines for other practitioners in the field on how to sensitize and activate citizens to reflect about AI. Lessons learned are provided on how the democratization of AI development and governance can be put into practice, especially among those with no prior knowledge or interest. The next section draws out participatory approaches in CS research, followed by the Methods section, which describes the participant profiles and the phase-based approach of amai!. Based on

democratic principles, the amai! program is implemented through four main pillars: (i) challenge-driven innovation for AI, (ii) public participation throughout all research stages, (iii) building capacities through awareness raising and education, and (iv) deliberation about societal impact. The Results section describes the main outcomes of these pillars during its program lifetime (2021–2024), together with its main challenges, limitations, and gains. Because deliberation in development and governance processes for AI is still very limited, recommendations for future practice are provided in the Discussion section on how to implement this.

## DEMOCRATIC GOVERNANCE OF ARTIFICIAL INTELLIGENCE THROUGH CITIZEN SCIENCE

With advancements in technology and increased access to AI tools, one could think that its democratization has become a reality. However, research studies show a de-democratization of AI, with a strong concentration of knowledge production by a small group of actors—mostly industry and technology firms (Kak and Meyers West 2023). Based on text analysis with help of machine learning, Ahmed and Wahed (2020) discovered that there is indeed an increase in firm-only publications in AI research, and that firms are mostly collaborating with elite universities. There is thus a growing concern that the future of AI is being developed by only a small group of actors, also labeled the technocratic community. These technocrats have authority based on their technical expertise, and rule a system of governance called a technocracy, in which their specialist knowledge and position are dominant in political and economic institutions (Meynaud 1968). However, as Sætra (2020) positions, a technocracy can both have its downsides and merits. The negative arguments focus mainly on the shortcomings of people and democracy, for example, people have limited capacities to participate, whereas the positive arguments focus on the benefits that can result from expert rule, such as efficiency and optimization.

In line with Birhane et al. (2022), Buhmann and Fieseler (2021), and Zoe Cremer and Whittlestone (2021), we advocate for a wider participation in the development and governance of AI. The goal is to ensure that decisions around AI usage, research and development, and other issues, reflect the needs and preferences of the people impacted (Gabriel 2020; Seger 2023), both end users of the systems and non-users. According to Park (2022), the active engagement of stakeholders throughout the entire development process will result in more inclusive

and responsible AI practices, that is, AI systems free of algorithmic bias, and products and services that are useful to and accessible for many. In this respect, the Council of Europe is currently drafting a framework for the democratic governance of AI (Bergamini 2020). This framework sets out ways and formats to ensure that AI is used to enhance democracy, for example, support for strengthening informational autonomy for citizens and for the participation of citizens in the dialogue on AI.

Diverse methods can be put into practice for the democratization of AI governance, such as the formation of multistakeholder bodies, representative deliberative forums, or participatory processes (Seger 2023). Among the diverse set of participatory processes, CS is an up-and-coming method of engaging lay people in scientific research. CS makes scientific research more democratic, with a more equitable engagement between experts and the lay public (Cavalier and Kennedy 2016). With diverse levels of engagement, participants are offered the opportunity to contribute in various ways to research projects, including contributing their ideas and insights, collecting data, and helping to define problems (Haklay 2018). Among the various CS studies that apply AI tools, participants are mostly engaged as algorithm trainers or teachers. They are involved in the collection and classification of data needed for training algorithms (Ponti and Seredko 2022). Once the AI models are trained, the machine is provided with a new set of data from which it produces a solution. Also here, participants can be involved by validating the algorithm classification results. This practice of supervised learning through the use of machine learning is a common example in CS, for example, for species identification, coding neuro-images, recognizing shapes and structures of galaxies, etc. (Franzen et al. 2021).

Seeing the novelty and imposing (negative) challenges of AI development, one might ask whether a stronger cross-disciplinary integration should occur between the social sciences and technology development, and especially with science and technology studies (STS) (Mahr et al. 2018). As such, the dynamics shaping participation in science and AI technology and its influence on society could be better explored. The risk of disengaging citizen scientists is also a particular concern since they are mostly involved in simple, routine tasks in AI research (Ponti and Seredko 2022). Therefore, it is necessary to (re-)organize projects and participation in different ways, for example, through citizen social science, whereby participants design the research questions (cfr. *CityS Health Toolkit*), or participate in the evaluation of ethical implications of a research project (Tauginienė et al. 2020; Albert et al. 2021). In the following chapters, the amai!-case study is presented as a good-practice example of how to engage citizens in diverse

ways in scientific research, supporting more democratic decision-making in regard to AI.

## METHODOLOGY

In this section, the target groups and the phase-based approach of the amai! program are described.

### THE TARGET GROUPS OF amai!

The amai! program targets all quadruple helix stakeholders, including industry, government, academia, and particularly civil society. The program specifically targets citizens who have no prior interest in or knowledge of AI. This latter target group is referred to as societal implementers, that is, citizens interested in societal themes and current affairs, and willing to think about new societal applications. Based on a large-scale survey of the amai! program, this target group is mostly female (56.5%), middle aged, and low to highly educated (Supplemental File I: Appendix A).

Through four societal themes—climate, mobility, health, and work—amai! sparks conversations on AI with this target group.

### THE PHASE-BASED APPROACH OF amai!

Amai! operates in four phases (Figure 1) and has been continuously ongoing since 2021. Each iteration lasts approximately 12 months and is aimed at democratizing AI development and governance.

Amai! is led by the Knowledge Centre Data & Society from the Vrije Universiteit Brussel and the Knowledge Centre on Citizen Science (Scivil) in Flanders (Belgium). The former specializes in legal, ethical, and societal aspects of AI and data-driven applications, while the latter in CS and participation. Amai! is funded by the Flemish Government's Department for Economy, Science, and Innovation within the Flemish AI Action Plan.

#### Phase one: collect ideas for research questions

In phase one, ideas for research questions are crowdsourced online or through in-person events, for example, with interactive booths. The main question in

the crowdsourcing campaign is “How can AI benefit your daily life?”. Participants are guided to reflect on and submit ideas about AI's potential through societal challenges, using brainstorming techniques, like the AI-wall and quiz, and guided conversations starting from citizens' daily lives and working up to idea formulation, not necessarily already linked to technology. All inputs are collected on the amai! online platform aiming for a minimum of 100 ideas.

#### Phase two: from research idea to concept

Starting from the gathered research ideas, the scope of potential research projects with AI solutions is defined in co-creation with stakeholders. Ideas are clustered per societal theme using keyword tags. These clusters guide the co-creation sessions in which citizens, civil society organizations (CSOs), AI-professionals, and policymakers co-define the scope of research projects with potential AI solutions. On average, five to six sessions across different regions of Flanders engage up to 25 stakeholders each. Participants are recruited via amai! communication channels (newsletter, social media), and partnering networks (e.g., public libraries and experience centers, CSOs within the four societal themes of amai!, etc.). The sessions are open to all, no prior knowledge is required.

The main methodology for the co-creation sessions is an ideation toolkit with tailored templates and AI Ideation cards (Supplemental File 2: Appendix B). The ideation toolkit collects input about (i) the problem statement: the collected ideas are written in a story form to better understand the issue; (ii) the challenge: what, why and who; (iii) idea prioritization; (iv) listing of potential technologies; and (v) the final desired solution.

#### Phase three: open call for funding

After the scoping of potential research projects with AI solutions, an open call for funding is launched, inviting consortia to submit proposals to turn the crowdsourced ideas into reality. Winning proposals receive funding up to 125,000 euros.

The call requires projects to (i) build on one or more of the crowdsourced research ideas; (ii) provide societal and innovative value through AI; (iii) engage citizens



**Figure 1** The phase-based approach of amai!.

through CS activities (e.g., collecting or analyzing data, reporting, co-creating the methodology); and (iv) involve at least two partners, one with AI expertise and one in the societal domain. The call is promoted widely across various networks to attract diverse stakeholder groups, including industry, research, governmental organizations, and CSOs.

Proposals are evaluated by a jury of experts in AI, CS, and science communication. Review criteria include (i) clarity of the project goals, including the link with crowdsourced ideas, the societal impact, and the added value of AI; (ii) methodology and workplan; (iii) CS approach; (iv) data plan; and (v) budget (Supplemental File 3: Appendix C). After pre-selection, a final decision is made via online public voting. Citizens are called upon to vote through the amai! communication channels, through cooperation with national media such as newspaper and radio, and through the networks of the participating consortia. Since iteration three, a citizen jury is organized to allow non-selected proposals from the public voting to receive funding. An open call for participation in the citizen jury is advertised through amai! channels and an independent online citizen panel. Candidates are selected for diversity in gender, age, occupation, and education level. Participants' motivation and interests in the societal themes of amai! are also considered. The citizen jury board convenes for two Saturdays. During the first day, they discuss and select criteria on which to judge the proposals, listen to pitches from proposal representatives (including Q&A), and score each criterion for each proposal. The second day involves a group discussion on the strengths and weaknesses of each proposal in order to finalize proposal rankings based on scores and feedback.

### Phase four: Implementation of citizen-driven research projects

Finally, the funded projects start addressing the research questions and developing the AI-solutions, together with relevant stakeholders.

Consortia receive methodological support from the program through workshops on CS, ethics in AI, and humane AI, along with regular peer sessions. This fosters a platform for sharing experiences and mutual learning. Projects are also receiving assistance in the development of a communication strategy for citizen recruitment and media outreach.

Phase four coincides with the next program iteration. This offers the opportunity to communicate about the projects and inspire citizens with concrete AI-solutions. Projects also receive post-completion support to secure further funding for scaling up.

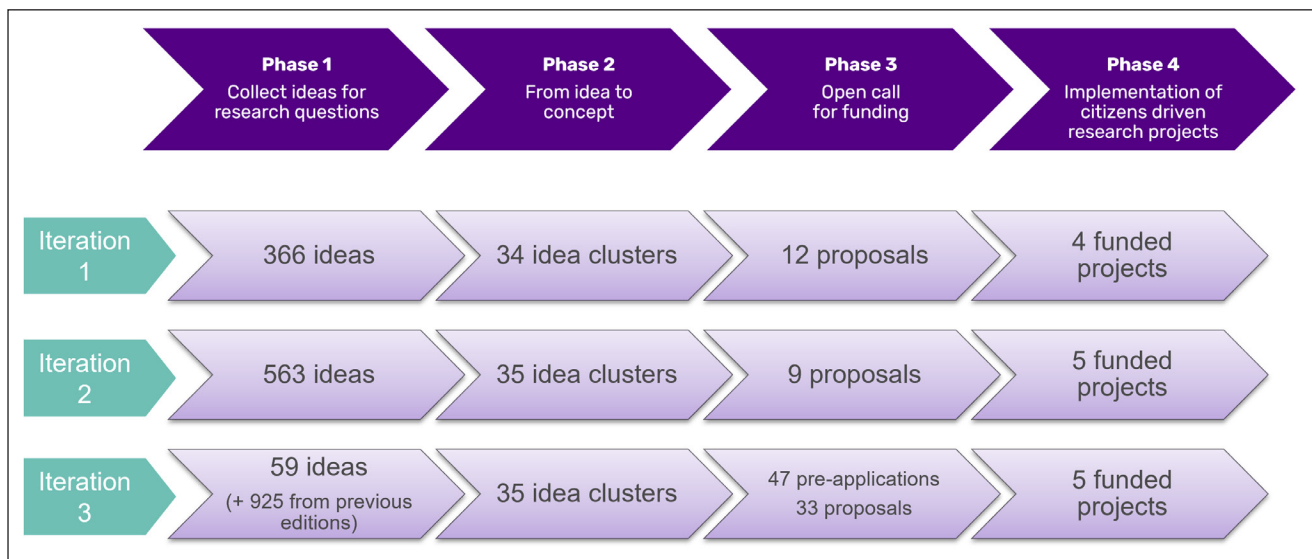
## RESULTS

In the following sections, the results are described based on the program's core democratic principles.

### PILLAR I: CHALLENGE DRIVEN INNOVATION FOR ARTIFICIAL INTELLIGENCE

The phase-based approach of amai! supports and facilitates citizen-driven research projects in the domain of AI. Across three iterations, approximately 1,000 ideas have been crowdsourced, and 14 research projects have been funded (See [Figure 2](#)).

Crowdsourced ideas surged between iterations one and two, owing to the shift from online idea collection towards in-person idea collection (due to the COVID-19



**Figure 2** Overview of main results per phase and per iteration of the program.

regulations during iteration one). Engaging participants through in-person events proved to be more effective and efficient, for example, at science festivals. Iteration three collected fewer ideas, focusing on reusing previous ones and boosting educational and outreach activities.

Iterations one and two received rather few proposals. In the third iteration, a comprehensive evaluation of the open call included semi-structured interviews with key stakeholders and past applicants. This led to adaptations, introducing a two-step procedure with intermediate feedback and matchmaking, opening the call for a longer period of time (from three to six months), extending project duration (from one to two years), and increasing the budget per proposal (from €75,000 to €125,000). These changes boosted the number of proposals from nine in iteration two up to 33 in iteration three (with 47 pre-applications).

The 14 funded projects cover various topics across the four societal domains (See [Table 1](#)). In mobility, two of three research projects focus on persons with disabilities. In the work domain, five projects have been funded, with four centered on school contexts. This theme, particularly involving schools and children, attracted more votes in the public voting and a higher score of the citizen jury.

The technology-readiness-level (TRL) of the funded projects is quite high. While the open call allows any TRL, most proposals centered on more mature technologies,

aligning well with citizens’ concrete ideas and involving many CSOs and university colleges in the consortia.

The funded research projects successfully support capacity building and citizen engagement. Being able to show concrete results not only demonstrates AI’s potential for societal challenges but can also motivate citizens to engage in the amai! program, since these results show that their input can lead to impactful results.

[Figure 3](#) shows how 16 similar crowdsourced ideas resulted in a funded CS project on litter monitoring using drones.

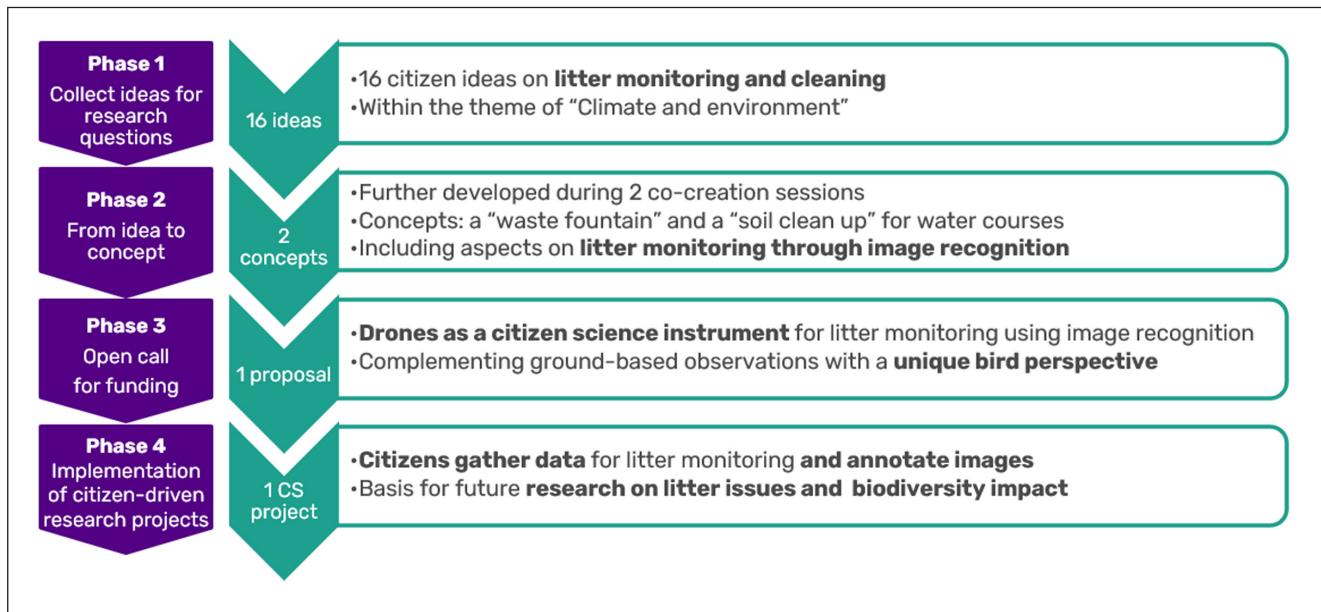
**PILLAR II: PUBLIC PARTICIPATION THROUGHOUT ALL RESEARCH STAGES**

In the amai! program, stakeholders—especially citizens—actively co-design citizen-driven research projects (See [Table 2](#)).

In phase one, the crowdsourcing campaign is the main participation method for collecting ideas for research questions, trying to reach as many citizens as possible. The crowdsourcing campaign operates both online and offline. Online participation requires citizens to make an active decision, while in-person events allow the amai! team to go where the people are (e.g., science festivals). In-person events have been more successful in engaging more people across iterations (See [Table 3](#)), leading to more submitted ideas.

	CLIMATE AND ENVIRONMENT	HEALTH	MOBILITY	WORK
Iteration 1	Monitoring trees: Can citizen-trained image recognition enhance tree mapping for better informed local climate policy decisions?	Personalized monitor for diabetics: Can AI improve type-1 diabetes management during physical activity with guidance on insulin dosing and carbohydrate intake?	Cycle path monitoring: Can citizen-collected data through smart bike sensors enhance cycling path condition assessment?	Live classroom subtitles for non-native pupils: Can live Dutch subtitles using Speech-To-Text in lessons aid non-native speakers’ comprehension, language skills, and confidence in speaking?
Iteration 2	Monitoring litter using drones: How can citizen-sourced drone data and image recognition aid in mapping litter impacts on biodiversity?	Sleep tracking and improvement: Can AI make meaningful predictions and suggestions for improving citizens’ sleep quality, based on eating, exercise and sleep habits?	Building accessibility map: Can speech-to-text and Natural Language Processing (NLP) enable citizens with typing or visual impairments to collect data on building accessibility?	Signaling learning and living difficulties at school: How can AI assist in signaling learning and living difficulties of students, while ensuring ethical considerations and practical application for teachers?  Language assistant for teachers: Can AI offer targeted feedback to teachers on language goals for multilingual learners by analyzing pronunciation, intonation, tempo, and language errors?
Iteration 3	Monitoring Bees: Can citizen-trained algorithms enhance the mapping of bees and gestation plants for identifying factors in winter bee mortality?	Explaining medical reports in lay terms: To which extent can AI enhance patient comprehension of medical reports and support patient empowerment?	Route planner for visually impaired people: How can AI-driven navigation apps enhance independent mobility for the visually impaired?	Sign language translator: How can a video-to-text search in the Flemish Sign Language dictionary enhance communication and inclusivity for the deaf community?  AI language learning buddy for non-native pupils: How can conversational image-based practice with a voice Bot improve Dutch language acquisition and reduce speaking anxiety for newcomer students?

**Table 1** Topics and main research questions of funded projects per iteration and theme.



**Figure 3** Example of how sixteen crowdsourced ideas led to a funded citizen science project on drone-based litter monitoring.

	1. COLLECT IDEAS FOR RESEARCH QUESTIONS	2. FROM IDEA TO CONCEPT	3. OPEN CALL FOR FUNDING	4. IMPLEMENTATION OF CITIZEN-DRIVEN RESEARCH PROJECTS
<b>Citizens</b>	Submit ideas	Define the scope of citizen-driven research projects	Public voting and citizen jury	Data collection Co-design Feedback
<b>Civil society organizations</b>	Promote idea submission in own network	Define the scope of citizen-driven research projects	Promote public voting in own network, Apply for funding	Consortium partner in funded projects
<b>Academia and industry</b>	Give feedback to submitted ideas	Define the scope of citizen-driven research projects	Jury member or Apply for funding	Consortium partner in funded projects
<b>Policy makers</b>	Promote idea submission in own network	Define the scope of citizen-driven research projects	Jury member or Apply for funding	Consortium partner in funded projects

**Table 2** Overview of the involvement of the stakeholder groups in each phase of ama!

In phase one, CSOs and policy makers act as an intermediary to promote the crowdsourcing campaign in their networks. AI researchers offer feedback and stimulate debate on the submitted ideas on the platform.

In phase two, the role of CSOs, researchers, industry, and policymakers becomes more prominent, as they prepare for the call. Through the co-creation sessions, they bring insight to the crowdsourced ideas, they help translate the ideas into more concrete research questions, and they form consortia through networking.

This stakeholder engagement continues by consortia, which consists of CSOs, researchers, industry, and policymakers submitting proposals for the open call in phase three. First, experts in AI, CS, and science communication evaluate proposals. Then, citizens vote on the proposals

that passed the expert jury to decide which proposals receive funding. In iteration one, 2,955 citizens voted for their favorite proposals; in iteration two, 2,455; and in iteration three, 8,026. Voting was promoted through the networks of the proposal consortia and through national public media (radio show and newspaper). Iteration three saw a significant increase in votes due to more proposals passing the expert jury and hence promotion by a larger number of consortia. Additionally, collaboration with a national newspaper further boosted participation.

In iteration three, the public voting was complemented by a citizen jury, in which 15 citizens met in person to review and rank the proposals that passed the expert jury according to their societal impact. Fifty-six citizens applied for the citizen jury, comprising mostly women (64%) and

highly educated citizens (61% with a higher education degree). Most applicants were above 50 years old (68%). From the 56 applicants, 15 citizen jury members were selected: seven men and eight women. The group was less balanced in age and education level, with mostly middle-aged and highly educated participants. A more detailed description of the sociodemographics can be found in Supplemental file 3: Appendix C.

The composition of the consortia consists mostly of colleges within universities. Their applied research focus aligns well citizens’ concrete ideas. Alongside industry and research, many governmental organizations (mainly cities and municipalities) and CSOs are involved in consortia, ensuring citizen involvement and uptake of the project outcomes (Supplemental File 4: Appendix D).

In phase four, citizens participate in the funded research projects through data collection, data analysis and annotation, the co-design of activities, and feedback sessions. Since most project teams lack experience in citizen involvement, they receive extensive support from the amai! team on this.

**PILLAR III: BUILDING CAPACITIES THROUGH AWARENESS RAISING AND EDUCATION**

To actively engage citizens in all research phases, they need a basic understanding of the technology. Therefore,

amai! focusses on raising awareness and building capacity among citizens, to pave the way for active engagement.

A communication funnel leads citizens from general awareness to active engagement in amai! (See Figure 4). At the top of the funnel, a wide outreach is achieved through public media collaboration, including with a national public radio broadcaster and a national newspaper, reaching a broad audience (typically one in ten persons in Flanders). The wide outreach directs citizens to the amai! social media and website, for information on amai! and AI. Next, citizens are invited to join amai! events, ranging from low-effort, accessible events such as an interactive booth at festivals, to more intense activities such as participation in workshops and idea submissions.

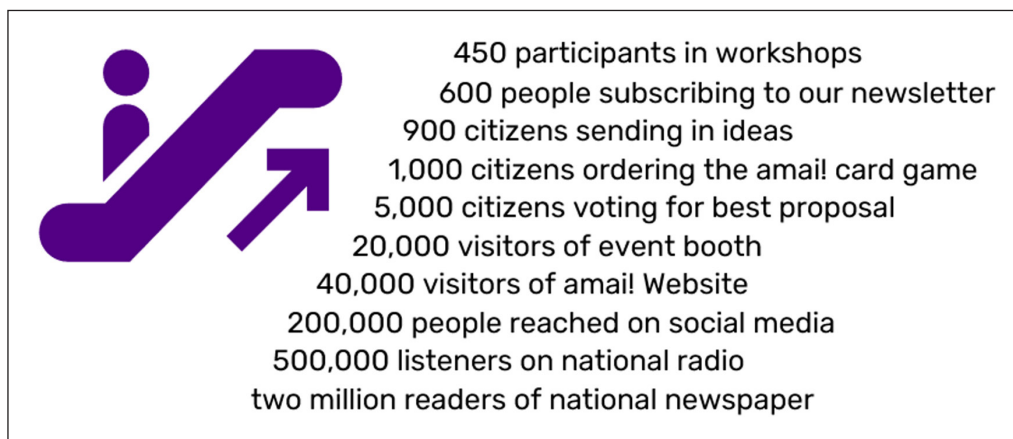
To support the communication funnel, various materials were developed to inform, enthuse, and actively engage the public. A comprehensive overview and detailed descriptions of all developed materials are available in the online amai! toolkit. Below an overview is given of the main materials:

One-way communication materials:

- AI stories: Introducing AI components with storytelling and examples linked to the societal themes of amai!
- AI game: Card game for children (ages 8+) introducing AI components.

	ONLINE		IN PERSON	
	NUMBER OF ACTIVITIES	NUMBER OF PEOPLE INVOLVED	NUMBER OF ACTIVITIES	NUMBER OF PEOPLE INVOLVED
Iteration 1	11	389	2	1,000
Iteration 2	4	139	35	20,191
Iteration 3	0	0	34	28,268

**Table 3** Number of phase one bookable activities (cfr. Pillar III Results) and number of people reached through these activities across three program iterations, categorized by online and in-person formats.



**Figure 4** Communication funnel of amai!.

- AI library: Collection of citizen-friendly AI tools, including artistic applications like Dall-E.
- AI and ChatGPT class materials: Educational resources for teachers in primary and secondary education.

Interactive materials and activities:

- Online tests:
  - o AI supermarket test: Citizens answer questions on supermarket habits to receive a personalized AI impact profile.
  - o AI compass: Citizens complete a questionnaire on a specific AI application (e.g., smart traffic lights) to receive a personalized compass highlighting their main concerns compared to the average.
- Bookable activities:
  - o Datawalk: A city tour where a guide explains AI applications across the city, fostering discussions among participants on AI possibilities and risks.
  - o AI information and brainstorm session: A session teaching participants basic AI principles followed by a brainstorm to come up with new ideas.
  - o Transcribathon: A community event engaging citizens to train AI through online annotation, for example, using Zooniverse.

- o AI wall and quiz: An interactive wall for events where citizens play the “AI or not” quiz by moving in front of a camera while judging if an application uses AI or not.
- o Teacher training sessions: Sessions for primary and secondary education teachers on introducing AI in their lessons.
- o Preconditions for AI: A workshop in which citizens discuss concerns and trust preconditions for AI.

All materials developed adhere to the following principles: a) accessible information that requires no prior AI knowledge, b) start from citizens’ daily lives and link with the societal themes of amai!, and c) fun elements to spark enthusiasm. [Figure 5](#) outlines developed materials with their main goals and settings.

**PILLAR IV: DELIBERATION ABOUT SOCIETAL IMPACT**

In iteration two, a guidance ethics approach was organized ([Tijink and Verbeek 2019](#)) to engage citizens in a dialogue on preconditions for AI, including “doom” and “boom” scenarios. Four workshops engaged 118 citizens on AI concerns and preconditions, resulting in a report and a

Activity	Goal			Setting			
	Informing	Actively involving	Discussing risks	Online	Big events and fairs	Dedicated workshops	Schools
<b>One-way communication materials</b>							
AI-stories	■			■			
AI-game	■						■
AI-library		■		■			
Class materials		■					■
<b>Interactive materials and activities</b>							
<b>Online tests</b>							
AI supermarket test	■			■			
AI compass			■	■			
<b>Bookable activities</b>							
Datawalk	■		■			■	
AI information & brainstorm session	■	■		■		■	
Transcribathon		■			■		
AI-wall and quiz	■	■			■		
Teacher training sessions	■	■					■
Preconditions for AI			■			■	

**Figure 5** Developed materials with their main goals and settings.

card set outlining preconditions about AI (e.g., related to autonomy, performance, reliability, etc.)

In iteration three, activities on societal impact were further supported through a citizen jury of 15 people. Whereas public voting gauges the broad support for proposals, the citizen jury focused on judging the social impact of the proposals. This led to a ranking of the five most impactful proposals, of which the first received funding.

## DISCUSSION AND FUTURE WORK

The amai! program is a forerunner in demonstrating how cross-disciplinary research, built upon participatory processes, can be established in the domain of AI. Hereby, amai! demonstrates the active role citizens can play in the formulation of research questions, the organization of participatory dimensions of research projects, and the evaluation of research projects submitted for funding. Throughout its phases, amai! applies citizen social science principles to foster critical debates on the influence of science and AI on society, and gathers scientific knowledge across various levels. First, through crowdsourcing, societal needs and ideas are collected in a CS database. Depending on participants’ science capital and AI literacy, these ideas may focus on a societal challenge and/or a societal and technological challenge (with or without a specific AI focus). This database is publicly available, annually updated, and undergoes necessary data cleaning and categorization. Second, ethical research is conducted on the consequences of science and AI in its cultural and social context.

Preconditions for ethical AI are collected, which pave a clear way for responsible research and innovation. Third, learnings are also collected in various science disciplines through the granted citizen-driven research projects. In phase four, there is a clear collaboration between scientists and people outside of academia, benefitting both parties. Researchers gather scientific evidence in their specific discipline (health, data science, environmental sciences, etc.), while participants can contribute to solving societal issues, and learn about science and technology.

In the following sections, implementation challenges of the amai! program are discussed, along with solutions, and remaining issues. Issues are categorized by the program’s four pillars. Figure 6 highlights a high-level roadmap of future actions, which are further described per pillar below. The Discussion concludes with general recommendations, guidelines, and potential pitfalls.

### PILLAR I: CHALLENGE-DRIVEN INNOVATION FOR ARTIFICIAL INTELLIGENCE

The open call ensures that the crowdsourced ideas and developed concepts lead to concrete realizations. Citizens and non-technological consortium members play an active role in ensuring that the submitted proposals are maximally challenge driven.

Several measures were taken to ensure that non-technological stakeholders, such as CSOs focused on societal themes, participate in the consortia. For example, allowing consortia to use more mature technologies lowers the participation threshold for stakeholders with a lower technology focus and a higher societal focus. Future iterations of the program could strategize on addressing

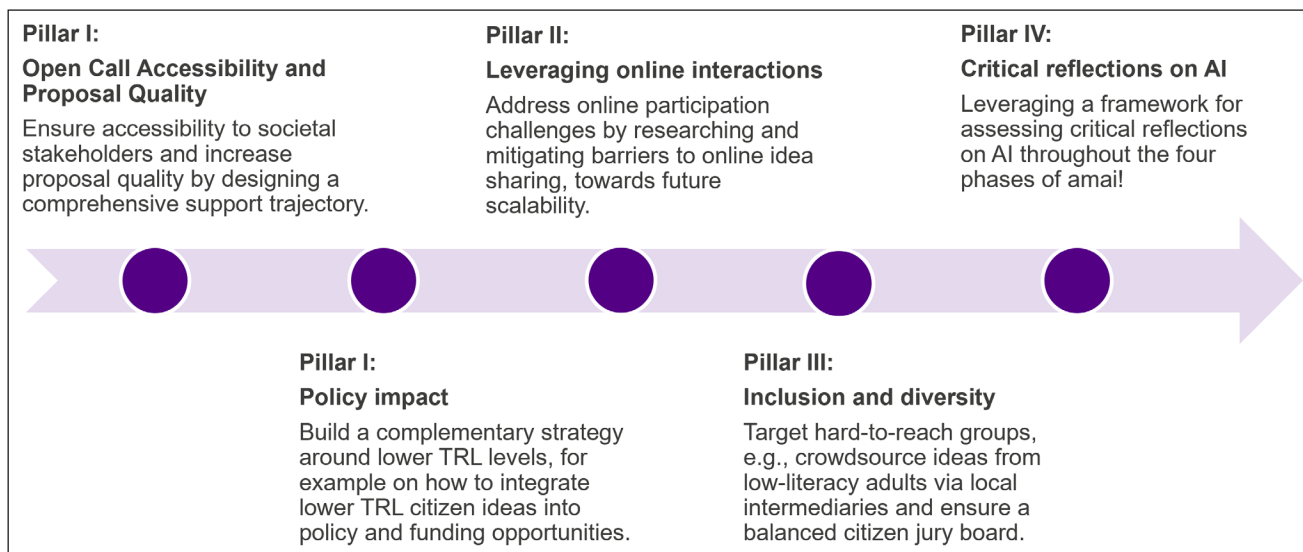


Figure 6 High-level roadmap of future actions.

also lower TRL levels where citizens' ideas are, for example, used for new policy directions or for funding opportunities.

In addition, the co-creation workshops guide stakeholders towards the open call, and stimulate connections between non-technological and technological stakeholders. Here, different approaches led to different results. In the first iteration, heavily curated co-creation topics excluded stakeholders whose challenges were not selected. The second iteration allowed consortia to build on any crowdsourced idea without co-creation sessions. However, this led to even fewer submissions. The third iteration reintroduced co-creation sessions, with a framework for collaboration and the ability to build on any crowdsourced idea. This resulted in the highest number of submissions. As such, a balance was found between guiding stakeholders without restricting them.

The extensive support offered to consortia also lowers the threshold for submitting a proposal, since the open call is very demanding. It requires proposers to start from a citizen's idea, establish collaboration between technical and social partners, incorporate a CS component, and create trustworthy AI. In the third iteration, a two-step procedure was introduced, allowing stakeholders to submit "premature" ideas, receive early feedback, and team up with others working on similar challenges.

Future work will focus not only on the call accessibility for stakeholders, but also on improving their proposal quality. Democratizing the call increased accessibility, but also led to varied submission quality. Three main areas for improvement highlighted by the expert jury are enhancing CS aspects, ensuring realistic AI components, and improving communication strategies. Detailed jury feedback can be found in Supplemental File 3: Appendix C.

## **PILLAR II: PUBLIC PARTICIPATION THROUGHOUT ALL RESEARCH STAGES**

Convincing citizens to participate in the program was challenging, in part due to the perceived complexity of AI. Although citizens are interested, they often feel they lack sufficient knowledge to take part. Coming up with an idea and sharing it requires reflexivity and puts participants in a vulnerable position. Participants often fear ridicule, thinking their contribution might be worthless or silly. Although the team made participation accessible by focusing on societal challenges and providing information, it still required significant effort to encourage idea sharing.

One-on-one conversations, shifting the focus from technology to personal interests and societal views, were most effective for convincing citizens to share ideas. The interaction also best occurs face-to-face, to ensure trust and informality. However, the COVID-19 crisis in the first iteration forced many activities online, resulting in lower

citizen involvement compared with in-person interactions. As such, the number of ideas was much higher in the second iteration when more offline activities took place. Online participants get more easily distracted and are quicker to drop out of activities. Also, one-on-one conversations are hard to facilitate online, and online interaction generates less trust, making it harder for participants to overcome insecurities.

As detailed in the Method and Results section, public participation is also facilitated in other phases, for example, by including the public in the final selection of proposals and by including them as citizen scientists in the selected projects. However, it does not suffice to simply give citizens the opportunity to take part in the scientific process as a means of democratization. Citizens need active guidance towards these opportunities and support to take part. Democratizing science through CS is an active process that not only requires opportunities for participation, but also sufficient time and energy to support citizens to participate.

Future actions include enhancing support for online participation and building trust in online contexts as first steps towards upscaling the approach.

## **PILLAR III: BUILDING CAPACITIES THROUGH AWARENESS RAISING AND EDUCATION**

### **Media collaborations**

As detailed in the Results section, a myriad of strategies was used to reach the target group of societal implementers. Bringing the message into traditional mainstream mass media outlets (newspapers, cable television, radio), not oriented towards a tech- or innovation-minded audience, proved particularly challenging. The team collaborated with national radio and a major newspaper, reaching one in ten people in Flanders. While highly recommendable, this requires significant effort to find mutual benefits for all parties involved. One point of attention is to safeguard the tone and content of the message, balancing the opportunities with the pitfalls and risks of AI, while allowing journalists to tailor it to their audiences. Finding this equilibrium is challenging and involves uncertainty, as news outlets are subject to last-minute changes and final publication checks are often constrained by time.

In future work, the team will continue seeking qualitative collaborations with major media outlets. Since novelty is crucial, finding new angles is a recurring challenge. This often requires rethinking and creating new short-term partnerships, rather than relying on past collaborations.

### **Formal education**

The program partnered with formal educational institutions to raise awareness and educate about AI. The team

developed educational materials for teachers to integrate the topic in their classes and train-the-trainer sessions to demystify the science behind AI. Materials focus on primary and lower secondary education to ensure all children gain a basic understanding of AI. Future efforts will target undereducated, low-literate adults through a tailored approach in collaboration with local intermediary organizations.

#### **PILLAR IV: DELIBERATION ABOUT SOCIETAL IMPACT**

The opportunities offered by AI cause both moments of amazement and moments of moral panic with citizens. How to use the technology for good and avoid the risks associated is an important question.

##### **Critical reflections on AI**

While the program includes deliberation on societal impact in each phase, it remains challenging for citizens to generate research ideas and identify risks simultaneously in phase one. In brief interactions (e.g., at big public events), the focus is therefor on idea generation, whereas longer sessions allow more structured critical discussions. The program also integrates critical thinking in other parts: the co-creation methodology of phase two and the supporting peer workshops in phase four include exercises on critical reflections, and both the expert and citizen jury criteria in phase three highlight critical assessment of AI.

Future actions will explore how to further integrate critical reflections on AI throughout the program. The program also aims to further integrate deliberation on societal impact within the funded projects, for example, by providing “guidance ethics” sessions (Tijink and Verbeek 2019) with citizens.

##### **Citizen jury**

Increasing the programs’ societal impact was a big driver in iteration three to include a citizen jury, in addition to the public voting, to determine which projects would receive funding. Public voting ensures funded projects have broad societal support, but it can become a popularity contest. To address this, citizens must vote for three proposals, making sure they not only vote for the one promoted by their network. The third iteration added a citizen jury, in which 15 citizens evaluated the societal impact of the proposals in more depth. While efforts were successful to balance jury members in terms of gender, the final composition leaned towards higher education levels, underrepresenting those with only primary education and those in the youngest age category below 35 years old. This bias likely influenced the

jury’s deliberations, potentially overlooking perspectives and needs of younger and less educated citizens.

Future work will develop additional strategies to reduce this bias, making sure the citizen jury reflects society at large, and societal impact is estimated from many different angles. Since its success, further partnering will also continue with CSOs and public libraries to remain a diverse audience for phases one and two of the program.

#### **CONCLUSION**

This paper delineates the amai! program’s approach to democratizing AI innovation and governance using CS as a participatory process. Amai! transcends the conventional confines of CS, primarily involving citizens as algorithm trainers, solely contributing to supervised learning processes through routine tasks. Instead, amai! places citizens at the heart of AI research and innovation by adopting a challenge-driven approach, fostering public participation in all research stages, enhancing capacities of citizens, and encouraging deliberation on the societal impact of AI.

The program balances participation with the requisite expertise. A key tenet of the program is the strengthening of citizens’ capacities, as a certain level of technological understanding is necessary to create meaningful contributions. While not everyone can be an AI specialist, everyone is able to express their preferences for how they want their lives and society to be impacted. Balancing inclusion and expertise is central to amai! and will remain so in the forthcoming years. In our view, this balance is crucial for reconciling technological advancement with democratic ideals.

The continuation of amai! is up for reconsideration on a yearly basis: Currently, the program is in its fourth iteration. As detailed in the Methods, Results, and Discussion, numerous refinements and changes have been implemented over the years. While the central pillars of the program remain unchanged, future iterations will continue to explore new ways to achieve higher impact and more profound forms of democratization in AI research and innovation.

#### **DATA ACCESSIBILITY STATEMENTS**

All crowdsourced ideas, published reports, and funded projects are accessible through the [amai! website](#). The activities designed within amai! are accessible in the [online amai!-toolkit](#).

## SUPPLEMENTAL MATERIALS

- Supplemental File 1: Appendix A  
Veeckman, C., Vaes, M., Verstraelen, K., and Duerinckx, A. (2021) *Een voorstudie naar het co-creatief oplossen van maatschappelijke uitdagingen met behulp van AI*. Belgium: Kenniscentrum Data & Maatschappij, Scivil Citizen Science Vlaanderen.

Available at (Dutch): <https://amai.vlaanderen/onderzoek#voorstudie>

- Supplemental File 2: Appendix B  
Duysburgh, P., Veeckman, C., Vaes, M., Duerinckx, A., Verstraelen, K., Van Laer, J., and Jacobs, M. (2021) *Welke ideeën hebben burgers voor AI? De kampvuursessies: van 352 vragen en ideeën voor AI naar 17 AI-concepten*. Kenniscentrum Data & Maatschappij, Scivil Citizen Science Vlaanderen.

Available at (Dutch): <https://amai.vlaanderen/onderzoek#rapport>

- Supplemental File 3: Appendix C  
Duerinckx, A (2024) *The jury process of the amai! open call for proposals 2023*. Kenniscentrum Data & Maatschappij, Scivil Citizen Science Vlaanderen.

Available at (English): <https://amai.vlaanderen/onderzoek#juryproces>

- Supplemental File 4: Appendix D  
Duerinckx, A., Duysburgh, P., Vaes, M., Van Laer, J., Veeckman, C., and Verstraelen, K. (2021) *Wat leren we uit de amai!-projectoproep van 2021?* Kenniscentrum Data & Maatschappij, Scivil Citizen Science Vlaanderen.

Available at (Dutch): <https://amai.vlaanderen/onderzoek#oproep>

## ETHICS AND CONSENT

The research conducted does not require acceptance from the human ethics committee. The participants were required to accept the privacy policy when submitting ideas or registering for events.

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## COMPETING INTERESTS

The authors have no competing interests to declare.

## AUTHOR CONTRIBUTIONS

All authors contributed substantially to the amai! program, including data collection (crowdsourced ideas) and data analysis (idea clustering), activity design for all four phases of the program. Annelies Duerinckx, Carina Veeckman, Karen Verstraelen, and Pieter Duysburgh contributed equally to writing the paper. Annelies Duerinckx and Carina Veeckman primarily revised the manuscript after review, with Karen Verstraelen and Pieter Duysburgh providing additional input. All authors approved the final manuscript.

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