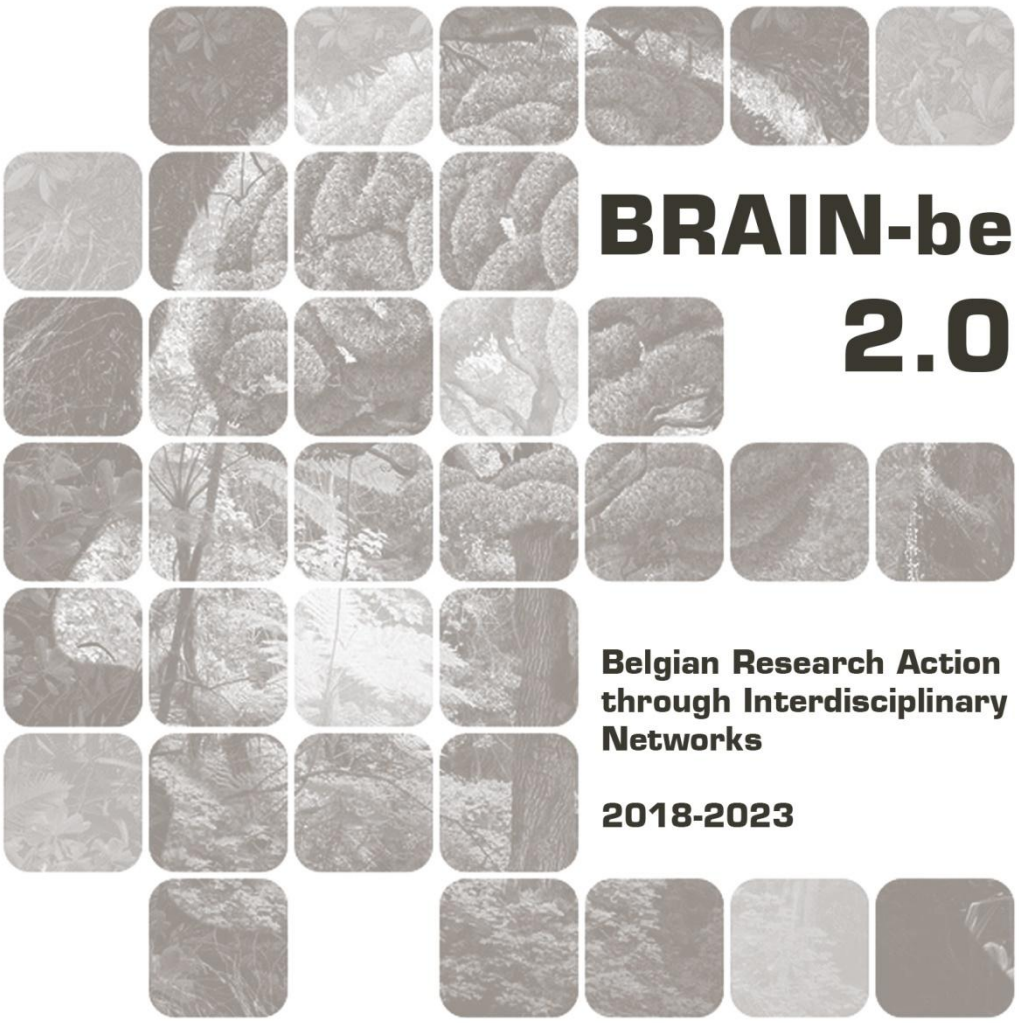

BECODIGITAL

Digital Co-Creation of Public Services with Citizens: Understanding Pre-Conditions, Technologies and Outcomes

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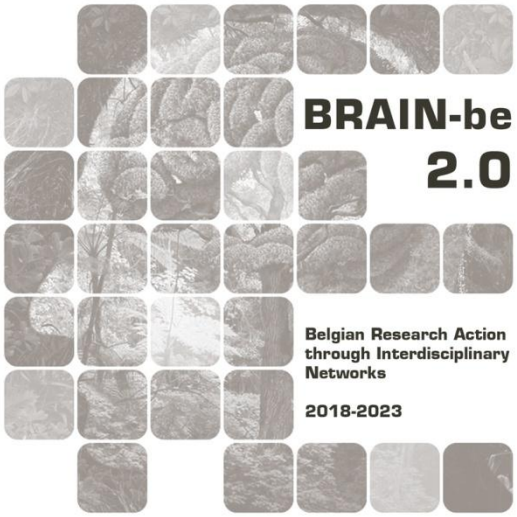

NETWORK PROJECT

BECODIGITAL

Digital Co-Creation of Public Services with Citizens: Understanding Pre-Conditions, Technologies and Outcomes

Contract - B2/223/P3

FINAL REPORT

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ABSTRACT

Digital government is increasingly expected to move beyond efficiency gains toward more citizen-centric, participatory, and inclusive forms of public service delivery. Digital co-creation offers new opportunities for governments to actively involve citizens in the design, delivery, and evaluation of public services. However, important knowledge gaps remain regarding the preconditions for inclusive participation, the effective combination of digital technologies, and the evaluation of the outcomes of digital co-creation initiatives. The BECODIGITAL project (2022–2025), funded under the BELSPO BRAIN-be 2.0 programme, addresses these challenges in the context of the Belgian federal government.

The main objective of BECODIGITAL is to develop and validate a practical and scientifically grounded roadmap to support inclusive digital co-creation of public services with citizens. The project specifically aims to: (1) identify and analyze the human, technical, and organizational preconditions for inclusive digital co-creation; (2) study how digital technologies, including emerging AI-based solutions, can effectively support different stages of the co-creation process; and (3) conceptualize and evaluate the outcomes of digital co-creation across product, process, and institutional dimensions.

BECODIGITAL results demonstrate that successful digital co-creation requires a careful alignment of stakeholder preconditions, co-creation methods, and digital technologies. Combining multiple online and offline methods within a coherent technological ecosystem is key where AI can play a valuable role in supportingco-creation. The project delivers a scientifically sound digital co-creation roadmap and an online toolkit for practitioners, offering concrete guidance to policymakers and public administrations seeking to implement inclusive and effective digital co-creation initiatives.

Keywords

Digital co-creation; digital government; citizen participation; public services; artificial intelligence; inclusiveness; co-creation outcomes

1. INTRODUCTION

The BELSPO BRAIN-be 2.0 BECODIGITAL project (2022-2025) focuses on connecting practical and scientific insights about digital co-creation.

The objective of the BECODIGITAL project is to develop and validate a practical and scientifically sound roadmap (consisting of organized guidelines) to support citizen co-creation through digital technologies in a federal government context, while ensuring that this co-creation is performed in an inclusive manner.

What is co-creation?

In this project we consider co-creation as defined by Torfing et al. (2019, p. 802):

"A process through which two or more public and private actors solve a shared problem, challenge or task through a constructive exchange of different kinds of knowledge, resources, competences and ideas that enhance the production of public value […] or services."

2. STATE OF THE ART AND OBJECTIVES

Digital government consists of the use of digital technologies to improve the internal functioning of administrations and the delivery of services to companies and citizens (Janowski, 2015). However, discussion amongst scholars is ongoing regarding what the next stage of digital government will be. Numerous authors call for a digital government that is citizen-centric (Hasan et al., 2018), open to external innovations (Bonina & Eaton, 2020; Lee & Kwak, 2012), or integrating citizens' input and ideas for smarter decisions (Simonofski et al., 2019). All these visions about the "next step" of digital government converge towards a changing relationship between citizens and government and argue for the digital co-creation of public services with citizens. Co-creation can be defined as a process in which actors exchange resources and jointly create value through an engagement interface(Leclercq et al., 2016). The confluence of four major factors has redefined the role of citizens in government to turn them into potential co-creators of public services instead of passive beneficiaries (Chantillon et al., 2017; Nambisan & Nambisan, 2013). First, citizens have increasingly higher expectations regarding public services and expect more personalized public services as well as opportunities for participation. Second, public organizations are limited by their resources, and their knowledge of what citizens need and therefore need innovative ways to develop solutions. Third, the problems faced by governments are increasingly complex (e.g. reaching sustainability goals) and call for collaborative approaches that include external partners, including citizens. Finally, the use of digital technologies allows to make the co-creation with citizens easier and more cost-effective.

The objective of the BECODIGITAL project is to develop a practical and scientifically grounded roadmap to support citizen co-creation through digital technologies while ensuring that this co creation is performed in an inclusive manner, and to validate it in a federal government context. Although the co-creation phenomenon is not new, the BECODIGITAL focuses on **three key innovative aspects related to co-creation** following the framing of Axelsson et al. (2010) a well-established theoretical framework that studies citizen involvement in digital government: (1) stakeholders' pre-conditions and engagement issues related to co-creation, (2) citizen co-creation via rapidly evolving digital

technologies providing new ways to engage citizens and (3) the evaluation of the outcomes of digital co-creation.

Objective 1: Understanding stakeholders' pre-conditions towards digital co-creation: Several studies (Holgersson & Karlsson, 2014; Khan & Krishnan, 2021; Letki & Steen, 2021; Steen, 2021; Wijnhoven et al., 2015) identified **motivational factors for citizens to co-create** and find that motivations of citizens to participate differ depending on the nature of the project. Besides the nature of the project, the motivation of citizens to participate can also be impacted depending on the nature of the co-creation method or the nature of the enabling digital technology (Rodriguez Müller et al., 2021). In addition, the **pre-conditions and barriers of stakeholders with lower digital skills** must be properly considered to avoid reinforcing the digital divide. Furthermore, literature focuses on citizens, but **other stakeholders such as political representatives, software developers, civil society organizations or public servants** also have important pre-conditions regarding co-creation (Lindgren, 2014; Van Eijk et al., 2019). In addition, the vast body of literature on technology acceptance provides numerous insights on psychological, task-related and technology-related motivational factors that may affect a citizen's willingness to co-create (Tamilmani et al., 2021). Bringing together the currently scattered results will allow to obtain a more thorough understanding of the roles, competences and motivations and barriers necessary to enable co-creation. The first objective is thus to gain a greater understanding of the human, technical and organizational pre-conditions for an inclusive co-creation, that **integrates inputs from a representative and inclusive set of citizens.**

Objective 2: Exploiting an ecosystem of digital technologies to enable co-creation : The use of digital technologies can make the co-creation process easier and more accessible (Macintosh et al., 2009; Toots, 2019). Although research can be found for each of the co-creation methods individually (e.g. digital platforms, sensing technologies, processing technologies, social media, etc.) (Lember et al., 2019), the **complementarity and coherence of these methods have hardly been studied, especially to reach the whole population including citizens with lower digital skills**. Porwol et al. (2016) underline the importance of building synergies between different methods. Co-creation methods are more effective when used in combination with each other in order to reach as many citizens as possible (including the non-digital natives) and ensure the validity and representativeness of the input collected (Berntzen & Johannessen, 2016).

In the BECODIGITAL project, we investigate the complementarity of co-creation methods to form a coherent ecosystem for digital co-creation, ensuring the participation of people with lower digital skills. In particular, we will explore how the **use of processing technologies can make sense of the citizens' contributions** from other digital co-creation methods such as sensors, social media or platforms. The available information can be overwhelming and difficult to process for policy-makers, who would therefore benefit from a better process/system to extract meaningful observations or even recommendations (Lago et al., 2019). This would allow bridging the gap between (representative) citizen sourcing and citizen co-creation concepts. Thanks to the knowledge acquired about the different co-creation methods, it will be feasible to **develop a scientifically sound roadmap for digital co-creation**, destined to support the projects of the federal government.

Objective 3: Evaluating the outcomes of digital co-creation : Many **positive outcomes** are identified within the co-creation literature such as bringing opportunities of learning (Irvin & Stansbury, 2004), enabling democratic participation and promotion of innovation in society (Linders, 2011), increased

service quality and policy effectiveness (Loeffler & Bovaird, 2018; Ansell & Torfing, 2021) and ultimately strengthening trust in government (Anthopoulos et al., 2007; Wang & Van Wart, 2007). However, several scholars warn about the potential **dark side of co-creation and value co-destruction** and mention that digital co-creation is too often studied through tech-optimism (Laud et al., 2019; Lember et al., 2019; Steen et al., 2018). Additionally, co-creation participation can also lead to tensions (Best et al., 2019), introduce costs, and increase the risk of bias (Irvin and Stansbury, 2004). It is key to evaluate both positive and negative outcomes of digital co-creation, allowing for co-creation methods to be iteratively improved and instantiated to reach their objectives. The exact relation between digital co-creation and these various outcomes is still a black box and calls for appropriate measures and metrics to assess and evaluate the outcomes of co-creation (Lember et al., 2019; Steen et al., 2018). In order to capture the diversity in co-creation outcomes, we propose to build on the policy network outcomes frameworks by Klijn & Koppenjan (2015) and Voets *et al.* (2008) which constitute a multidimensional outcome concept. Their frameworks are developed along three dimensions of outcomes – substantive or product outcomes (e.g. innovation, quality and goal achievement), process outcomes (e.g. trust, fairness, honesty and mutuality), and institutional or regime outcomes (e.g. robustness and resilience) – and three levels of assessment – the individual participants, the co-creation network, and the community. Ideally, there needs to be a balance of performance on the three outcome dimensions and on the three levels of assessment. There might be **trade-offs between different kinds of outcomes** and the balance of outcome dimensions may shift throughout the policy life cycle (Klijn & Koppenjan, 2015). By developing and testing such a **multidimensional outcome assessment framework**, we extend the conventional understanding of (digital) co-creation outcomes, and allow for a balanced evaluation of such outcomes which sheds light on potential trade-offs and threshold levels beyond which positive outcomes strengthen each other (or inversely, thresholds below which outcomes negatively reinforce each other). Moreover, our analyses enable to understand the impact of the preconditions (WP1) and the co-creation methodology (WP2) on the outcomes.

3. METHODOLOGY

In this project we selected the most appropriate methodologies according to their compatibility with the research objectives and in view of ensuring the feasibility of completing the research tasks within a 3-years implementation period. As a consequence, BECODIGITAL was overall based on three main methodological building blocks in its research design: the design science research approach; the selection of relevant use cases; the action research methodology.

First, we choose to rely on the Design Science Research (DSR) approach as overarching approach to achieve the objectives of this project. This well-established approach within the information systems and management communities allows creating an artifact that serves human purpose by generating new knowledge for researchers but also directly usable by practitioners. In the BECODIGITAL project, the artifact is the digital co-creation roadmap (and its related toolkit), drawing insights from the pre-conditions, digital technologies and outcomes of the co-creation process. As theorized by (Hevner et al., 2004), DSR consists in three iterative cycles:

a) the **Relevance Cycle** to identify the objectives of the artifact from the practical environment. This cycle ensures the relevance of the design artefacts for the application domain by acquiring requirements from and validating results in the application domain.

b) the **Rigor Cycle** to ensure that the artifact builds upon and contributes to the knowledge base. This cycle also provides grounding theories and methods along with domain experience and expertise from the foundations' knowledge base into the research.
c) the **Design Cycle** to design and evaluate the artifact.

In the Design cycle, we will develop the co-creation roadmap (WP2) establishing an ecosystem of digital co-creation methods (processing technologies, sensing technologies or online platforms). This digital co-creation roadmap will then be evaluated with proper outcome metrics on a selected use case within the Belgian federal government (WP3). In the Relevance cycle we provide input to the design by identifying the pre-conditions regarding digital co-creation in the federal government (WP1).

Furthermore, the validation through the selected use cases will ensure the applicability of the designed artefact in the Belgian administration at large by providing additional input for the refinement of the design in the design cycle. In the Rigor cycle, we will ensure that the digital co-creation roadmap contributes to the knowledge base by disseminating relevant results in scientific outlets and in practitioners' workshops. This cycle also sources the grounding theories and methods along with the relevant experience and expertise into the research. We need to better understand the (pre)conditions for digital co-creation, and thus contribute to more tailored theories and concepts related to digital co-creation. The relevance and rigor cycle will be transversal to the whole research project and will allow to publish the results of BECODIGITAL in well-established scientific outlets.

More specifically, within each work package, different methodologies were used to achieve their objectives and subobjectives.

3.1 Preconditions of digital co-creation

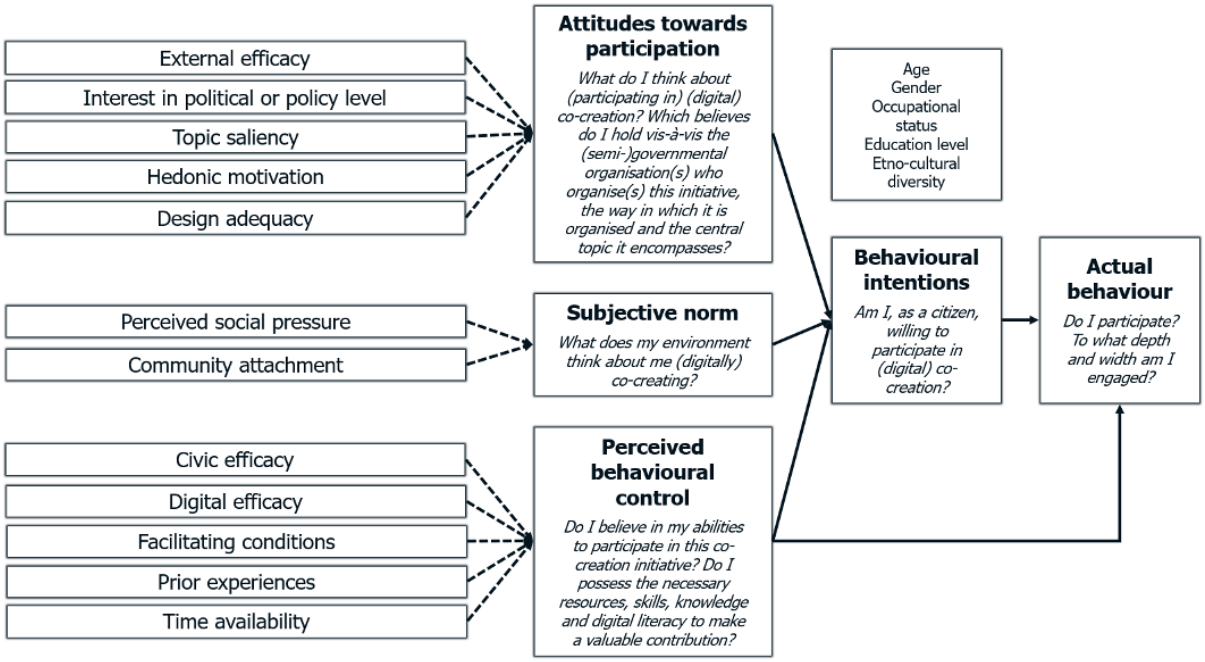
For the study of stakeholders' preconditions, WP1 deployed a triple research set-up. First, we conducted a General Population Survey (GPS) among Belgian citizens (n=1,035) to determine which pre-conditions best explain citizens' willingness to participate in different steps of a (digital) co-creation initiative. Because willingness to co-create ultimately precedes actual co-creating behaviour yet does not coincide with it, we also (second) a Use Case Survey (UCS) among citizen co-creators at national (i.e., the Carto Map Viewer and Corona Consultations), regional (i.e., Amai! Vlaanderen) and local level (Burgerbudget Genk) recruited from the cases we interviewed within the frame of the project. We wanted to know whether the variables that appeared to increase intentions to participate in co-creation or citizen participation were also present among the citizens that ultimately participated in co-creation. In other words, could we conclude that what contributes to high intentions may also be a good predictor of ultimate behaviour, and that the recommendations we derived from the GPS analysis were, therefore, relevant? If so, these insights and recommendations could be further explored based on internal stakeholder preconditions or the difficulties and challenges experienced by organisers of digital citizen participation or co-creation. Insights into these internal stakeholder preconditions were gathered through a focus group with follow-up committee members on the one hand and case interviews on the other. Each of these three steps (the GPS, the UCS, and the internal stakeholder interviews and focus group), that translated into the Policy Report on Stakeholder Pre-conditions and the concomitant Citizen Monitoring Instrument will now be briefly explained.

<u>The General Population Survey (GPS) using an Experimental Design set-up to assess citizen pre-conditions</u>

An online survey experiment was designed to investigate (a) the effect of different co-creation configurations (i.e., organised in an analogue, digital or mixed fashion) on respondents' intent to participate in (different steps of) a local co-creation initiative and (b) the characteristics of those respondents for whom step design and configurations appear to make a difference. The survey contained six modules:

- Given the weight of audiovisual material in our experimental design, the survey commenced with an eight-second test video and follow-up question about its content to check whether the incorporated media worked properly on respondents' devices. The test comprised the **first module.**
- The **second module** continued with a first set of more general questions about respondents' demographical characteristics (e.g., age, gender and language spoken at home), local community or neighbourhood attachment and opinions on their local governmental bodies and politics.
- A first intermediary video (equating 57 seconds in Dutch and 68 seconds in French) started the **third module**, explaining the notion of co-creation to respondents. Respondents were made clear that engaging as a citizen can be done in various ways, as it can entail more than simply voicing an opinion or voting for a preferred idea or solution. Moreover, citizens can get involved in many different topics. The video deliberately explained this without delving into particular examples, as those might prime respondents' answers in the subsequent experimental module of the questionnaire. After the video, respondents completed questions concerning their prior experiences with co-creation, their beliefs about the value of citizen participation and their estimation of their ability to contribute. Up to this point, the questionnaire went the same for all respondents.
- After this second set of questions, **respondents** were **randomly assigned to one out of four video conditions**. In each condition, a one-minute video invited them to the same local co-production initiative comprising four distinct yet sequential steps. More specifically, respondents were invited by their local authority to (a) share an idea, suggestion or opinion for a municipal redevelopment project, (b) vote for those ideas, suggestions or opinions that looked most appealing, (c) discuss in-depth those ideas, suggestions or opinions that received the most votes with 40 fellow citizens and (d) help to materialise and deliver the ideas discussed. The conditions, however, differed from one another in the way they were configured: some were organised in an analogue fashion (taking place in person at the municipal or city hall), whilst others invited respondents to participate digitally (i.e., through a participation platform, video-conferencing tool or app by the city or municipality).
- In all **fourth modules**, respondents were asked to indicate **how likely** they were **to participate** in each step. Moreover, respondents who indicated a time insufficiency to engage in the previous module (i.e., approximately 30% of the sample) were offered small ‘yes’ or ‘no’ follow-up questions about whether they would or would not consider participation in each of the four steps if it were configured a different way (i.e., digital instead of analogue or vice versa).

Given that the **fifth and sixth modules** are connected to other objectives within BECODIGITAL's third work package, they are not elaborated on here. Nevertheless, the entire questionnaire took approximately 12 minutes to complete and was conducted using Qualtrics software among a sample of Belgian citizens between 18 and 89 years old, representative for gender, age, educational attainment and region (i.e., proxied by language spoken at home) between April 18 and May 16, 2024, with the Belgian panel service BPact. After data cleaning, we retained a sample of 1,035 respondents. Respondents' intention to engage in one or more steps of the co-creation initiative served as the dependent variable throughout all our analysis. As independent variables, we analyzed all evaluative beliefs such as derived from the preceding literature review, wanting to know which ones determined co-creation intensions and are thus best considered in activation strategies. In sum, each variable in the underneath model, inspired by Theory of Planned Behaviour (TPB) was tested:



The testing was guided by the following research questions:

1) When (i.e., during which modes and concomitant participation methods) does a digital configuration make a difference in *citizens' intentions* to co-create?

2) Among which citizens does a digital configuration affect *co-creation intentions*?

   a. How do personal demographics (i.e., age, gender, educational attainment and occupational status) and evaluative beliefs (i.e., attitudes towards participation, subjective norm and perceived behavioural control) associate with Belgian citizens' intentions to co-create?

   b. Do personal demographics (i.e., age, gender, educational attainment and occupational status) and evaluative beliefs (i.e., attitudes towards participation, subjective norm and perceived behavioural control) associate differently in co-creation stages organised digitally vs. in an analogue fashion?

   c. Which points of attention regarding personal demographics (i.e., age, gender, educational attainment and occupational status) and evaluative beliefs (i.e., attitudes towards participation, subjective norm and perceived behavioural control) can be drawn for (semi-) governmental actors who wish to involve a diversified set of citizens in the digital co-creation of policies, services and/or regulations?

3) Which personal demographics (i.e., age, gender, educational attainment and occupational status) and evaluative beliefs (i.e., attitudes towards participation, subjective norm and perceived behavioural control) characterise *citizens who digitally co-create* with a Belgian federal, regional or local (semi-) governmental actor?

   a. Do these personal demographics (i.e., age, gender, educational attainment and occupational status) and evaluative beliefs (i.e., attitudes towards participation, subjective norm and perceived behavioural control) differ fundamentally between digital co-creation initiatives organised at the federal, regional and local level?

   b. How do the characteristics of Belgian citizens willing to participate compare to those who have already truly co-created with a Belgian federal, regional, and local (semi-)governmental actor through digital means?

   c. Which points of attention, based on the UCS dataset and interviews, can be drawn for (semi-) governmental actors who wish to involve Belgian citizens in the digital co-creation of policies, (e-)services and/or regulations in a meaningful way?

4) What common *challenges* do organisers of digital co-creation encounter *internally*?

   a. Where are these challenges situated in the production model of performant digital co-creation?

   b. Which points of attention regarding internal pre-conditions can be drawn for (semi-) governmental actors who wish to digitally co-create policies, services and/or regulations with external stakeholders?

5) Which overarching *recommendations* can be formulated regarding inclusive digital co-creation with citizens in a Belgian federal context?

In order to answer those, we first explored whether intentions differed significantly based on the co-creation steps (ideation vs. voting, deliberation and co-delivery) and their configuration (analogue vs. digital). To that end, a one-way repeated measures ANOVA and multiple t-tests were used. Furthermore, we reflected on the results of the small 'yes' or 'no' follow-up questions about whether respondents' would (still) take part in a particular step if it were organized differently (i.e., digitally instead of in-person and vice versa). Second, we preformed ordinary least square (OLS) linear regressions to assess the association between respondent demographics and evaluative beliefs on the one hand and their intentions to engage in a four-step local co-creation initiative on the other. In this step, we also compared the results of steps held in an analogue fashion to those organized digitally.

Third, we took the OLS regression analyses further by subjecting them to a classification and regression tree analysis (CART). This machine learning technique allowed us to visualize the hierarchical importance of the pre-conditions (i.e., demographics or evaluative beliefs) and their interactions in predicting our dependent variable (i.e., respondents' intentions to co-create). The combination of both techniques enabled us to translate the results of the GPS into guidelines on how to configure different co-creation steps and points of attention to involve a diversified set of citizens when doing so.

The Use Case Survey (UCS) to assess citizen pre-conditions

An online use case survey (UCS) was designed to investigate the characteristics of citizens who moved beyond the point of behavioral intentions and truly participated in digital co-creation with a Belgian (semi-)governmental actor or entity. That way, the UCS supplemented the GPS as it allowed us to examine the connection between behavioral intentions on the one hand and actual behavior on the other. Did the UCS respondents display the characteristics we would logically expect based on those that stood out in the four different steps and combined configurations of the GPS? Or did we witness noticeable differences? Four distinct digital co-creation initiatives at the national (i.e., CartoWeb.be and the Corona Consultations), regional (i.e., Amai! Vlaanderen) and local level (Burgerbudget Genk) that partook in the Baseline Measurement interview set-up (see D.1.1.1), agreed to also lend a hand to the UCS. Through calls in their online newsletters, NGI/IGN, Sciensano, Scivil and Stad Genk invited and encouraged the participants in their digital co-creation initiatives to complete the UCS. The UCS mirrored the GPS question items in as far as possible to allow a meaningful comparison. Eventually, we received 75 entire completes (i.e., respondents clicking through the survey from the beginning until the end). Compared to the Belgian population distributions, this sample proved less of a representative outtake, yet that was also not the objective as we did hypothesize difference between the overall Belgian population and those citizens in particular that were willing to participate in (digital) co-creation. After all, we wanted to learn from this difference and derive recommendations on how to active the unlikely participants so that augmented inclusion in digital co-creation initiatives could be achieved.

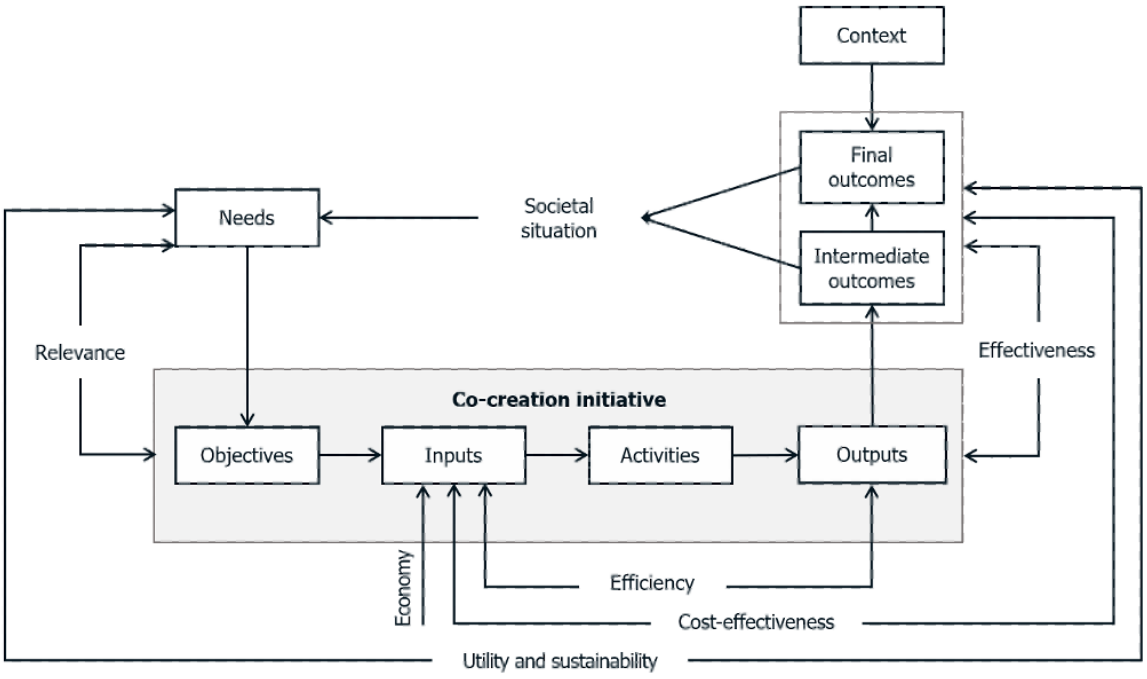
Analysis of the UCS results proceded in four steps. First, we provided a brief case description of the digital co-creation initiatives (i.e., CartoWeb.be and the TopoMapViewer; the Corona consultations; Amai! Vlaanderen and Burgerbudget Genk) that helped us to interpret the assembled survey data correctly. Second, we described, discussed and compared the descriptive statistics of each case. Third, we then compared these to the pre-conditions that emerged prominently from the GPS results using one-sample t-tests (where normality assumptions allow) or non-parametric Wilcoxon signed-rank tests (where normality assumptions do not allow) for the scale variables and chi-square goodness-of-fit tests for our categorical variables (i.e., prior experience and time insufficiency). We will considered the value or percentage distribution we observed in the GPS in each of these tests as the hypothesized population value or distribution. Do the values or distributions of these variables rose to the same level or followed the same pattern when based on actual behavior as when based on behavioral intentions? Did we find striking differences, or did our UCS data confirm the trends we had already observed in the GPS results? In other words, how well did behavioral intentions assist us in predicting eventual behavior? Finally, we synthesized our findings into recommendations

The focus group and interviews to assess internal stakeholder pre-conditions

Within the frame of the third Follow-Up Committee meeting (March 25, 2024), a **focus group** discussion was held on internal pre-conditions. **Prior to the meeting**, committee members could fill out a small Qualtrics **survey** in Dutch, English or French containing the following questions:

- Question 1. What **internal barriers or difficulties** did you already encounter when setting up digital co-creation with citizens? *(These may be of all kinds and can, for example, range from personal barriers to political-administrative burdens or technical difficulties. Indeed, we are interested in frequently encountered barriers regardless of their nature)*
- Question 2. **How** can the internal barriers or problems you described above be **overcome**? In other words, what do you see as minimum internal conditions for organising digital co-creation with citizens?
- Question 3. What strategies are being used internally to make digital co-creation with citizens as inclusive a story as possible?
    - A. First, consider **strategies to include citizens**.
    - B. Second, consider **strategies to include co-workers internally**.

Their answers were preliminarily analysed and structured according to the 'Production model of Performance' by Van Dooren et al. (2015) (see figure below) and added to a shared Miro board to engage with interactively during the focus group discussion.



Insights from the use cases supplement input from the focus group members. Within the frame of the Baseline Measurement, key stakeholder interviews were organised to gain a coordinator perspective on 14 Belgian digital co-creation initiatives (so-called 'use cases') at the federal, regional and local levels. More precisely, with these interviews we aspired to broaden our understanding of (a) the

stakeholders (such as citizens) involved in digital co-creation or the co-creation of e-services, (b) strategies for (inclusive) engagement and (c) potential barriers encountered along the way. To answer research question four (i.e., 'What common challenges do organisers of digital co-creation encounter internally') and formulate overarching recommendations for the organisation of inclusive digital co-creation in line with research question 5, the interviews were analysed thematically using a priori coding. More specially, all pieces of information that connected to (a) internal barriers, (b) external barriers and (c) coping strategies or recommendations were classified in a first coding round. In a second coding round, the codes connecting to internal barriers were revisited and recoded according to the nature of the barrier.

Taken together with the GPS and UCS analysis results, the analysis of this third qualitative part allowed for a deepening of recommendations with regards to the digital co-creation stakeholder pre-conditions.

3.2 Mechanisms of digital co-creation

The focus of WP2 on different co-creation methods involved the development of contributions related to the characterization and the design of these methods and technologies.

Characterization of AI technologies for co-creation

To evaluate current and future AI-enhanced solutions for co-production, we develop a typology as a methodological tool to facilitate the comparison between current solutions and instances from different fields.

Typologies are primarily conceptual top-down approaches which are deductively built based on first order constructs or dimensions (Bailey, 1994). These dimensions are combined into ideal types that represent a unique combination of values within the describing dimensions. The development of a typology allows us to define ideal types of AI solutions for online co-production activities. In a still emerging topic, we consider that the definition of these ideal types can help researchers to understand the different characteristics of these solutions and to build more complex approaches.

While typologies commonly follow a conceptual approach, an empirical study of the phenomenon under review may help to derive a typology (Stapley et al., 2022). Thus, as a first step, we reviewed the literature on current AI solutions from which we could derive the essential dimensions. Overall, the searched provided 493 articles that were then filtered to 50 based on the evaluation of the abstracts. Subsequently, we used the snowball method where the key articles found through the Scopus search were used as a starting point to find other relevant papers. In total, 69 papers were used to develop the typology and identify existing solutions in the literature.

We initially coded all papers based on their methodology, AI contribution and field of application. We took inspiration in the four steps' typology building approach of Kluge (2000): definition of analyzing dimensions, grouping cases, analyzing empirical regularities and finally constructing the types. In this

work, the main question assessed by the typology refers to how AI is involved in the different tasks within a digital platform for co-production. Thus, as part of the first step, papers were mapped into a list of all encountered AI techniques and their role. This allowed us to group the different works and analyze their relationships. Based on this classification, and grouping, two main dimensions were extracted. The first dimension regarded the level of automation and the role of AI (Sætra, 2021). The second dimension was based on the scope, from individual to collective, at which the AI can help in collaborative pro cesses (Chiang et al., 2023). These two dimensions, and the different spectrum values retrieved from the literature, were used to build the proposed typology and to derive six ideal types.

In addition, while iteratively developing the typology, we were guided by four criteria (Scott & Davis, 2015):

- The typology is intuitively sensible, as it captures the intuitive variables associated to the interaction with AI in a collaborative process. This criterion was used in the evaluation of the literature and the deduction of common variables.
- The typology is collectively exhaustive and mutually exclusive. Our typology accounts for all types of AI-enhanced activities, not only the ones related to digital platforms. At the same time, it provides mutually exclusive archetypes which are not necessarily independent. High level approaches, such as overarching AI architectures, would be considered a modular combination of some of these types.
- The typology has a construct validity. It defines specific spectrum values associated to each ideal type and it differentiates from other AI typologies (Hoekstra & van Veenstra, n.d.; Sætra, 2021). These criteria resulted in the addition of a second axes to represent the level at which the AI assistance is carried out, while the spectrum values were based on existing definitions associated to these dimensions.
- The typology should be conceptually elegant. In this case, it provides six ideal types based on two intuitive dimensions that rely on clear concepts.

<u>Design of tools for co-creation</u>

The project BeCoDigital implied the development of a series of artifacts: a modelling tool for co-creation processes and design principles for AI-driven digital participation platforms. In both instances, we used Design Science Research as the main methodology to structure the development of these artifacts.

Modelling tool for co-creation.

In this case we relied on Design Research Science (DSR) to generate new knowledge for researchers but also directly usable by practitioners, which are precisely the main goals of this work. DSR methodology can be defined by three iterative cycles: the relevance cycle, the rigor cycle and the design cycle

As part of the *rigor cycle*, we initially reviewed the literature concerning the different online and offline co-creation methods and the existing models related to the description of these methods. This review

of the literature allowed us to build upon existing models and to define which are the important elements of the implementation of co-creation methods.

To design and develop the proposed model, we make use of the existing theory in social network analysis (Wasserman & Faust, n.d.). Based on the fundamental aspects of social network representation, we define the key dimensions of participation processes extracted from the co-creation literature so to properly generate all the elements of the network-based model.

The *relevance cycle* in this work concerns the validation of the model in the citizen participation context, and the possible added value provided by this new approach. These questions have been initially answered by implementing the presented model to different use cases found in the literature. This exercise helped to demonstrate that the model can be applied to different methods, how it can be implemented, and to show its potential. This research design approach is summarized in Figure 1.

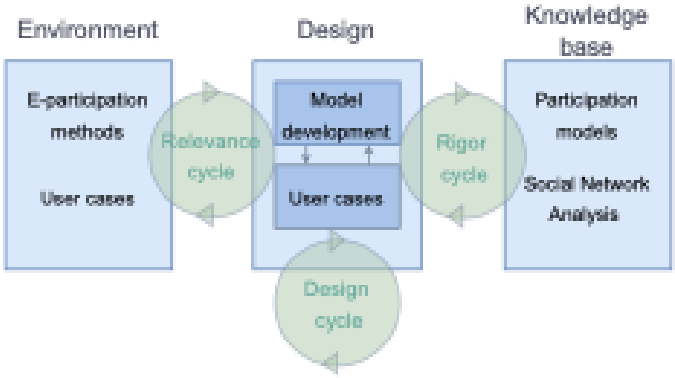


Figure 1: Design science methodology applied to the developing of the model

The relevance cycle was carried out at the literature review level. We selected four use cases where detailed information about their implementation could be found online, either in scientific literature or on websites or and reports. The first two use cases were selected due to their similarities in the goal of the e-participation, citizens involved in service development, and their use of equivalent offline methods. The two other use cases showcase projects which were focused on citizens involved in the decision making.

Design principles for digital participation platforms

Design principles are prescriptive statements that indicate how to do something in order to achieve a certain goal (Gregor et al., 2020), in this case, creating an AI architecture for DPPs that considers both technical and social challenges.

There exist several ways to develop design principles and there is an equally large number of definitions. Based on the definition of (Jones & Gregor, 2007), in this paper we derive the so-called *Principles of* form and function. These principles focus on the architectural composition and functionalities of the artifact. In the case of digital participation platforms, this means which are the AI-driven components characteristics, their functions and how they connect with the other components (Blaschke et al., 2019).

The methodology followed to obtain these principles is inspired by the steps proposed by (Vaishnavi & Kuechler, 2007). We extracted the meta-requirements from the literature and a focus group -(i) awareness of the problem-, we developed design requirements specifics to DPPs -(ii) suggestion-, we used two kernel theories to define the design principles -(iii) development- and we validated these principles based on interviews with different types of experts -(iv) evaluation-. The overall methodology followed to derive these principles is illustrated in

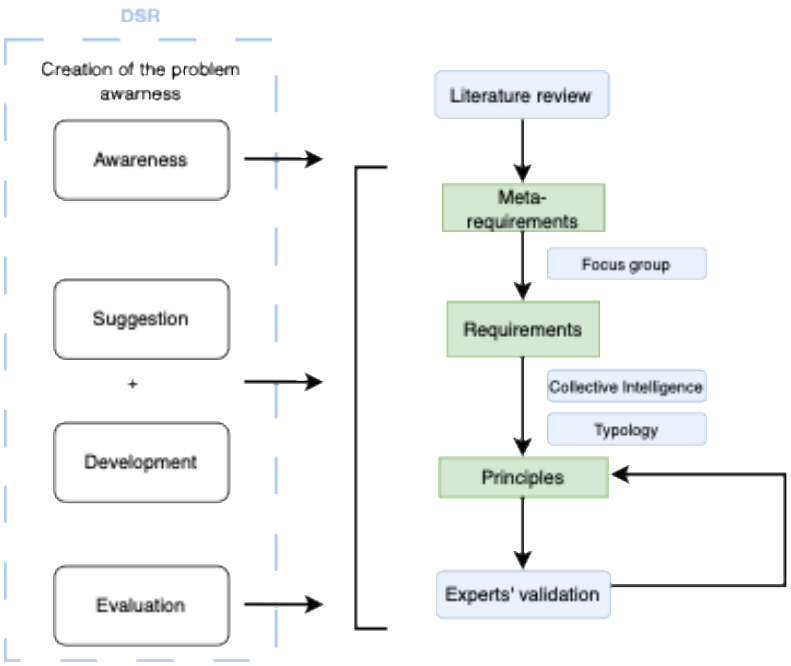


Figure 2: Scheme of the methodology employed adapted from (Vaishnavi & Kuechler, 2007)

According to (Wache et al., 2022), there is a wide range of abstraction levels in the formulation of design principles. This diversity, however, introduces uncertainty regarding the appropriate level at which design principles should operate. Building on the classification of (Wache et al., 2022), we aim to develop Quadrant II design principles. These principles are characterized by a relatively low level of abstraction, a high number of distinct concepts described and greater suitability for implementation. To reach this level of abstraction and ensuring that the design principles address specific requirements of the use of AI in DPPs, we follow a similar approach to (Haße et al., 2022; Herm et al., 2022). This involves aggregating meta-requirements (MRs) into the so-called key requirements or design requirements (DRs) (Koppenhagen et al., 2012) which are subsequently linked to our design principles (DPs). Meta-requirements describe fundamental prerequisites on a high abstraction level, that are necessary to fulfill the objective of a broad class of artifacts (Walls et al., 1992), while design requirements are prerequisites that have a lower level of abstraction, specific to the class of artifacts under study to (Haße et al., 2022). This approach enhances traceability in the derivation of the DPs by linking them to DRs rather than directly formulating them from MRs, ensuring that the design requirements are meaningful in the DPP context.

In this work, we aimed to develop supportive design principles (Möller et al., 2020). Supportive design principles are principles that provide prior knowledge before the design of the artifact itself (Schermann et al., 2009). Similarly to (Matheus et al., 2021), we adopted a deductive approach to

derive the design principles from general laws and insights. Thus, we first derived meta-requirements deductively and then refined them based on input from experienced users in a focus group to generate design requirements, inspired by (Gebbing, 2022).

Meta-requirements can be collected in different ways, e.g., from scientific literature, kernel theories, case studies or expert interviews (Möller et al., 2020). In our case, we relied on the scientific literature to extract preliminary meta-requirements. To achieve a proper overview of the literature, we performed a structured literature review in the areas of digital participation platforms and civic AI (Vom Brocke et al., 2015). The first area provided a broad view of AI technologies used in DPPs and other online ideation activities. The second area reviewed added a more general vision on the use of AI in the public sector. Civic tech is referred to the use of technologies to leverage and increase democratic participation. Consequently, civic AI refers to AI solutions specifically designed to empower citizens and enhance their participation in the policy-making process (Duberry, 2022).

We generated codes to identify possible barriers, potential utility, risks or beliefs of using AI in digital participation platforms and, more broadly, in the public sector. For each code, we linked specific statements from the literature, obtaining a list of codes with a definition and illustrative examples. Then, we conducted an axial coding (Strauss & Corbin, 1998) based on the following categories: political, economical, human and social, and technological (Matheus et al., 2021). This first step provided a preliminary categorization of the types of requirements identified in the literature and ensured a sufficient coverage, as evidenced by the high degree of saturation achieved.

Within these categories, concepts were grouped based on similarity, providing the first meta-requirements. Meta-requirements address a generalized class of goals rather than specific, more context-dependent goals (Venable, 2006). In our case, they pertain to the use of AI in the public sector rather than its application in DPPs. Thus, similarly to (Herm et al., 2022) ,we scrutinized these meta-requirements in the next step through a focus group, operationalizing them into design requirements more directly associated with digital participation platforms.

The focus group (FG) activity involved} 13 lead users and lasted 2 hours. The participation in this focus group was diverse, and composed by public servants, digital platform developers and academics. The focus group was organized as an open discussion around five key questions regarding AI in digital platforms: current uses of AI, benefits of using AI, barriers of the use of AI, areas that would benefit from the use of AI and the requirements to use AI. The FG was recorded, and key statements were extracted from the transcription of the meeting. First, we processed this data as user stories (Becker et al., 2022), which were then classified using the same coding scheme applied in literature review. The outcome of the focus group did not introduce any additional dimensions.

Following the advice of (Koppenhagen et al., 2012), we adopted a logical content aggregation approach to synthesize meta-requirements into designed-requirements. This aggregation into design requirements was conducted deductively and iteratively within the research team, using the user stories collected from the FG as a tool for refinement (Pan, 2022) of these preliminary requirements into a set of design requirements tailored for DPP. This refinement process involves framing or “updating” design requirements or design principles (Möller et al., 2022), in this case, specifically for digital participation platforms.

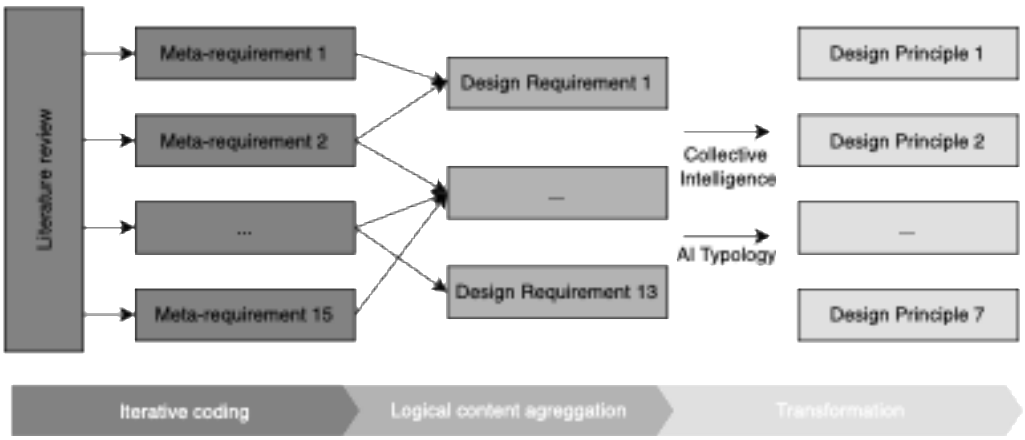


Figure 3: Design principles development inspired by (Haße et al., 2022)

(Möller et al., 2020) define three different ways to generate design principles: deriving them directly from a knowledge base, from an on-going or finished design process or as a response to requirements. In our work, we followed the responsive approach, where the principles were iteratively generated by the different members of the research team, directly linking them as answers to the design requirements.

We used two kernel theories, Collective Intelligence (Pöhler et al., 2021) and a typology of AI-based solutions in DPPs (Bono Rossello et al., 2024), to derive the design principles. This is one of the 5 mechanisms for Kernel Theory Use defined by (Möller et al., 2022), in which kernel theories are employed to transform one object (design requirements) into another (design principles).} In the DSR context, kernel theories refer to underlying theoretical concepts from natural, social, or design sciences that provide an explanatory basis for the design of an artifact (Jones & Gregor, 2007). This methodological approach to deriving design principles was also applied in (Chanson et al., 2019; Feine et al., 2020), to guide the design research process in a more formal and generalizable manner (Möller et al., 2022).

Finally, the design principles were validated based on the framework for light reusability evaluation proposed by (Iivari et al., 2021). Design principles are not always formally validated and this is even less common in the case of supportive design principles (Gebbing, 2022), given the constraints associated with the lack of an existing artifact. Precisely, the validation framework proposed by Iivari et al. is designed to evaluate design principles when testing and empirical evaluation of the DPs is not possible, as demonstrated in (Herm et al., 2022). This is the main reason it was used in this work. The main usability criteria within this framework are:

- *Accessibility* focuses on how comprehensible the design principles are for the target community.
- *Importance* allows the validation of the practical relevance of the DP within the context of its application.
- *Novelty* and insightfulness determine if the DP provides practitioners with new knowledge.
- *Actability* and guidance define the degree at which the design principle can be followed and carried out in practice.
- *Effectiveness* aims to evaluate the potential impact of the DP in performance.

The validation phase was carried out through semi-structure interviews, using a version of the initial guide provided by (Iivari et al., 2021). This approach allowed us to gather diverse insights regarding the importance of the principles as well as their novelty and practicality.

The principles were evaluated individually and in the order introduced in the paper. We started each principle's validation by presenting it without additional information. This helped us assess its accessibility without introducing any potential bias from an introductory explanation. This was followed by a semi-structured interview where the remaining elements were discussed. Given the widely differing profiles of the participants, the goal was to obtain as much information as possible regarding the specific elements that affected each criterion (e.g., why the importance might be low, or under which conditions a principle might be effective). This also helped externally validate the accessibility of the principle by ensuring that both the interviewee and the researcher understood it in the same way.

3.3 Outputs of digital co-creation

The third work package focused on identifying, conceptualizing, and empirically validating the outcomes of (digital) co-creation. The methodological approach combined conceptual framework development with empirical validation through practitioner feedback and a large-scale citizen survey.

Development of the outcome framework

The first step involved the development of a framework to capture and categorize the different types and levels of outcomes resulting from co-creation initiatives. The framework was theoretically grounded in earlier literature on collaborative governance and citizen participation (Voets et al., 2008; Hood, 1991; Bentzen, 2022; Best et al., 2019). This body of work informed the identification of three outcome types (product, process, and institutional) and levels (micro, meso, and macro). Together, these dimensions form the foundation of the outcome framework that structures the assessment of co-creation outcomes.

To assess the conceptual clarity and practical applicability of the framework, three semi-structured interviews were conducted with Belgian public administration practitioners directly involved in organizing one or more co-creation initiatives. In addition, one focus group was organized with participants from a co-creation initiative. These helped refine the definitions of outcomes and dimensions in the framework.

Empirical validation

The primary method for validating and refining the outcome framework was an online survey conducted in collaboration with WP1. Participants were recruited via an online survey panel, ensuring a mostly representative demographic distribution regarding gender, age, and level of education. Table 1 offers a detailed breakdown of the sample, which largely corresponds with Belgian national demographic statistics. It consisted of three main components:

1. A video experiment in which respondents were randomly assigned to one of four conditions representing different participation channels (fully analogue, fully digital, or two mixed (hybrid) sequences). Respondents were asked to estimate expected outcomes after viewing a multi-phase co-creation process.

2. A conjoint experiment using a multi-question design to measure preferences regarding design features of co-creation initiatives, including participation channel, governance level, phase, and bindingness. Conjoint experiments present respondents with hypothetical scenarios and ask them to choose their preferred option (Kolcava et al., 2021).
3. A series of Likert-scale items measuring the perceived importance of different (micro-level) outcomes.

The survey data allowed for analyses of citizens' expectations, preferences, and priorities concerning co-creation outcomes, as well as the influence of digitalization on these outcomes.

4. SCIENTIFIC RESULTS AND RECOMMENDATIONS

We divide this section based on the three main objectives of this project: 1) Understanding stakeholders' preconditions, 2) Digital technologies for co-creation and 3) Evaluating the outcomes of digital co-creation.

Then, we present the two general deliverables of this project:

- A roadmap for digital-cocreation
- Online toolkit for practitioners

4.1 Preconditions of digital co-creation

For the study of stakeholders' preconditions, WP1 first constructed a utile instrument or measurement tool to gauge citizens' willingness to digitally co-create based on the theory of planned behaviour by Ajzen (1991). According to TPB, a person's behavioural intentions herald their non-routine behaviour, such as participation in a co-creation initiative through digital means. Behavioural intentions themselves are shaped by three evaluative beliefs: (a) attitudes towards the particular behaviour, which, in this case, involves a weighing-up of the pros and cons of participation; (b) subjective or perceived social norm, which refers to the pressure to participate a person perceives to emanate from one's social environment and; (c) the estimation of one's ability to actually portray the behaviour, also termed perceived behavioural control. Within each of these three categories, we then plugged in variables repeatedly confirmed by research antecedents to affect participation intentions and that could also be tested within our experimental GPS and UCS, examples included interest in (local) politics and hedonic or intrinsic motivation to participate in the first category. For a detailed description of each of these variables as well as research findings, the reader is referred to deliverables 1.2.1 and the Policy Report in Stakeholder Pre-conditions for more information. Here, however, we will limit ourselves to an overview of the main analysis results and the recommendations we were able to derive from them.

Based on the OLS regressions and CART analyses on the GPS data in combination with the UCS data and reflection gathered from the internal stakeholder focus group and interviews, it was possible to distinguish between two types of variables and, consequently, two types of recommendations regarding activation strategies: (a) the recurring and step-independent key variables that organisers of co-creation ideally always focus on, such as hedonic or personal motivation and a sense of self-efficacy (either in civic or digital terms such as the confidence in one's own skills to contribute digitally or easily learn how to and be able to put one's opinion or ideas in words), and (b) the occasional and step-dependent variables that organisers can address later or when relevant, based on the activation

methods (e.g., ideation exercises, voting or deliberation opportunities) chosen. Within the first group, we included the following recommendations:

- **Communicate clearly what participants can gain** from engaging in co-creation (such as a sense of enjoyment, gratification, belonging, meaningfully contributing to their neighbourhood and surroundings, learning something news, or increasing the number of one's acquaintances).
- **Emphasise** that every contribution matters and **truly everyone can** (learn how to) **participate** (meaningfully).
- **Empower** by adequately preparing **participants** and providing sufficient support throughout the initiative (in both digital and content-related aspects) to avoid adverse knowledge and skill imbalances.

Within the latter group, we include the following recommendations, which are more dependent on step or activation methods:

- **Specify** the **amount of time needed** to contribute.
- **Leverage** the **target audience's interest in local politics** and elaborate on the link between politics, policymaking, service delivery, and their contribution.
- **Make** the **contributions** of individual participants in digital co-creation **visible** to fellow citizens by removing anonymity, while bearing in mind that this may imply an additional barrier for some groups.
- **Showcase** (digital) co-creation **success stories** and best practices.
- **Adopt transparent and frequent communication** regarding citizens' contributions.

In ideal circumstances with unlimited financial resources, staffing and digital design capabilities, each of these variables is, of course, taken into account.

Finally, we proposed a **recommendation that**, in essence, **precedes** consideration of **many of these variables** and, in a sense, is somewhat separate from them, but which can nonetheless influence their implementation:

- Actively **evaluate the advantages and disadvantages of analogue, digital, hybrid, and mixed co-creation designs** considering (a) the outset objectives, (b) necessary internal inputs and/or resources, (c) planned activities or activation methods in relation to the target audience and (d) desirable outputs and outcomes, including how to measure them.

Throughout the policy report on stakeholder pre-conditions deliverable, each of these recommendations is provided with more depth, foundation and concrete examples. However, it would be going too far to reproduce them in full here.

4.2 Mechanisms of digital co-creation

The second objective of the BeCoDigital project concerns the study of the different mechanisms that can assist in digital co-creation. A range of offline and digital methods can be used to support co-creation activities. In that regard, one of the goals of the project was to better understand the implications of using these methods across different co-creation stages by characterizing their advantages and disadvantages. We do so by mapping co-creation methods and technologies to the phases they suit best.

Acknowledging that co-creation requires the combination of multiple methods to engage stakeholders in an optimal way, we also develop a modeling approach that can be used to visually represent co-creation processes and the methods they employ. This makes it possible to identify shortcomings in co-creation processes and to visualize how methods can complement one another.

We pay special attention not only to participating in the co-creation process but also to developing tools for monitoring it, particularly in the context of crowdsourcing.

With a more specific focus, we also evaluate the potential use of AI technologies. We do this through two main phases: (i) evaluating potential uses of AI by developing a typology, (ii) establishing a series of design principles for implementing AI in citizen co-creation platforms.

Co-creation methods

Simonofski et al. (2019) identified a range of 8 methods that can be used to co-create public services with stakeholders. Although these methods have been identified primarily with citizens in mind, they are applicable to other stakeholders as well. These methods are described below. For each, we discuss their advantages and disadvantages. These methods are flexible in the way they can be implemented and can thus be used at any co-creation stage (e.g., co-commissioning, co-design, co-delivery, co-assessment).

Table 1: Summary of the advantages and disadvantages of co-creation methods

Method	Advantages	Disadvantages
Interview / Group discussion	• High applicability • Low skills required to put in place • Not so time-consuming for citizens • Allows getting individual views (interviews)	• Not so attractive for citizens • Time-consuming to get a lot of citizens • Less clear output
Representation	• High applicability • Low skills required to put in place • Not time-consuming at all for citizens • Provides a cost-effective solution for hard-to-reach stakeholders • Intermediaries can be mobilized across projects	• Risk of mismatch between the intermediary's perceptions and reality • Stakeholders might be frustrated to not be directly involved • Not so attractive for citizens
Workshop	• Clear output • Allows reaching consensus	• Time-consuming to organize

	• The agenda is largely driven by the participants	• Requires the availability of multiple participants • Demands specific facilitation skills
Online survey	• Allows large-scale participation • Attractive to citizens • Allows robust measures and comparisons	• Results can be hard to explain since they consist of numbers without explanations • Needs be carefully designed before large-scale distribution since it is difficult to remobilize respondents in case of mistake
Dedicated software	• Allows large-scale participation • Attractive to citizens • Specialized features supporting different types of co-creation	• High cost • Novel channel for most stakeholders • Challenge of integrating different platforms
Social media	• Channel already known by governments and citizens • Comes at no or little cost • Large-scale participation	• Low quality of inputs • Inputs are scattered and difficult to retrieve exhaustively • Large amounts of unstructured data to process • Requires technical skills to process data if it is too large
Living lab	• Longitudinal involvement across the project • Supports iterative experimentation • Clear output	• High cost • Challenge of stakeholder retention • Less known method
Prototype testing	• Delivers a clear output • Attractive for citizens • Supports rapid iteration • Delivers scientifically valid measures of some qualities of the service	• Some evaluation methods are time-consuming to put in place • Requires specific expertise

Based on these characteristics, we propose an indicative match between these phases of the co-creation process and these different methods. This mapping is shown in Figure 4.

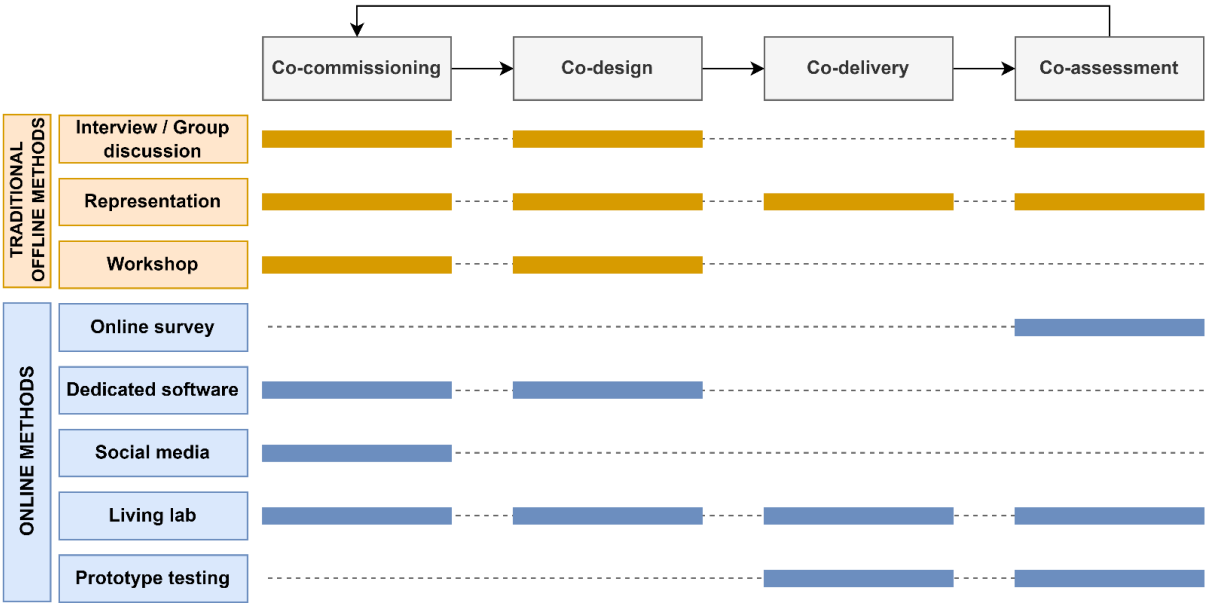


Figure 4: Best matches between co-creation stages and methods.

Technologies for co-creation

In order to implement the co-creation methods, a range of different technologies can be used. In this section, we describe four general types of such technologies and provide examples on how they can implement a given method within each co-creation phase that we identified as a good match for the method.

We propose a manageable overview of technologies describing general types and following (Lember et al., 2019), who investigated the use and impact of technologies in the context of public service co-creation. Due to the additional complexity and the vast number of technologies under the umbrella of Artificial Intelligence (AI), we provide a more fine-grained overview of AI uses in co-creation, illustrative examples, and practical guidelines to implement AI in co-creation in a separate section.

Sensing technologies. Sensor technologies refer to smart or wearable devices that make it possible for stakeholders (in most cases, citizens) to collect data in a new way. This follows the idea of "citizens as sensors" (Goodchild, 2007), in which citizens are "used" to jointly map a territory (Sieber & Johnson, 2015) Data can be collected either automatically or manually. For example, in the "Curieuzeneuzen in de tuin"[1] project, thousands of volunteering citizens have installed sensors in their backyard (i.e., automated data collection) to provide a collective picture of soil quality in Flanders. In the "Databusters"[2] project, citizens use an application to collect geolocalized data manually on the field. The application has been used to, e.g., map the road signs in a municipality. The collected data can be used to diagnose and better understand a problem, to develop a data-based service, and to evaluate the impact of a policy or a service (i.e., by comparing it with data collected before).

[1] https://curieuzeneuzen.be/waar-we-meten/tuin/
[2] https://www.futurocite.be/databusters-appli-chasseurs-donnees/

Communication technologies. Communication technologies enable machine-mediated interaction between a government and stakeholders, or across stakeholders. There exist a variety of communication tools. Some are already ubiquitous, such as videoconference tools, phone, or social media. Others rely on well-established paradigms but are much less widely used. They include, for example, websites on which stakeholders can raise issues, discuss ideas, or vote (Berntzen & Johannessen, 2016; Shin et al., 2024) . Yet others come in the form of emerging technologies. For example, Simonofski et al. (2024) investigated how Extended Reality, that encompasses Virtual Reality and Augmented Reality, can be used to involve citizens in urban planning projects. This technology can be used to collaborate with citizens around design alternatives that they could help refine. Another example is the Citizen Dialogue Kit (Coenen et al., 2019), which consists of small displays deployed in the urban environment and running a survey asking the opinion of passersby. Depending on the question asked, this can be useful to e.g., better understand an issue or evaluate the impact of a policy or a service.

Processing technologies. Processing technologies encompass technologies that are useful to make sense of large quantities of data, such as big data analytics, cloud computing, and machine learning. Although some co-creation methods have the advantage of enabling large-scale participation, this also comes with a data overload challenge for the government who will have to exploit the data. This is a problem when the data is unstructured, in the form of text such as a set of ideas proposed by stakeholders. Machine learning techniques can be used on such data to e.g., identify the main topics (Shin, 2023), which can be visually presented to support decision-making (Simonofski et al., 2021). This is also a challenge for the stakeholders contributing data. If the data is too vast for them to make sense of, they are more likely to contribute redundant data, only feeding more into the data overload issue. Processing technologies can alleviate this issue by e.g., recommending similar data to help stakeholders spot contribution identical to theirs (Bono Rossello et al., 2024), or providing interactive data exploration mechanisms based on the “overview first, zoom and filter, then details on demand” paradigm (Clarinval et al., 2023).

Actuation technologies. Actuation technologies can perform physical actions independently from a human, even though its sequence of actions might have been programmed by a human. A well-known example is robots used on production lines, which, once started, can move autonomously. Examples are rarer in the context of public service co-creation, but one that has recently gained prominence is 3D printing. This technology allows cheap and rapid prototyping, which is convenient to support rapid co-creation iterations. For this reason, they are found in living labs (Gascó, 2017).

Based on the properties and constraints of these technologies, we propose the following mapping (see Figure 5) with respect to the phase of co-creation and the type of method.

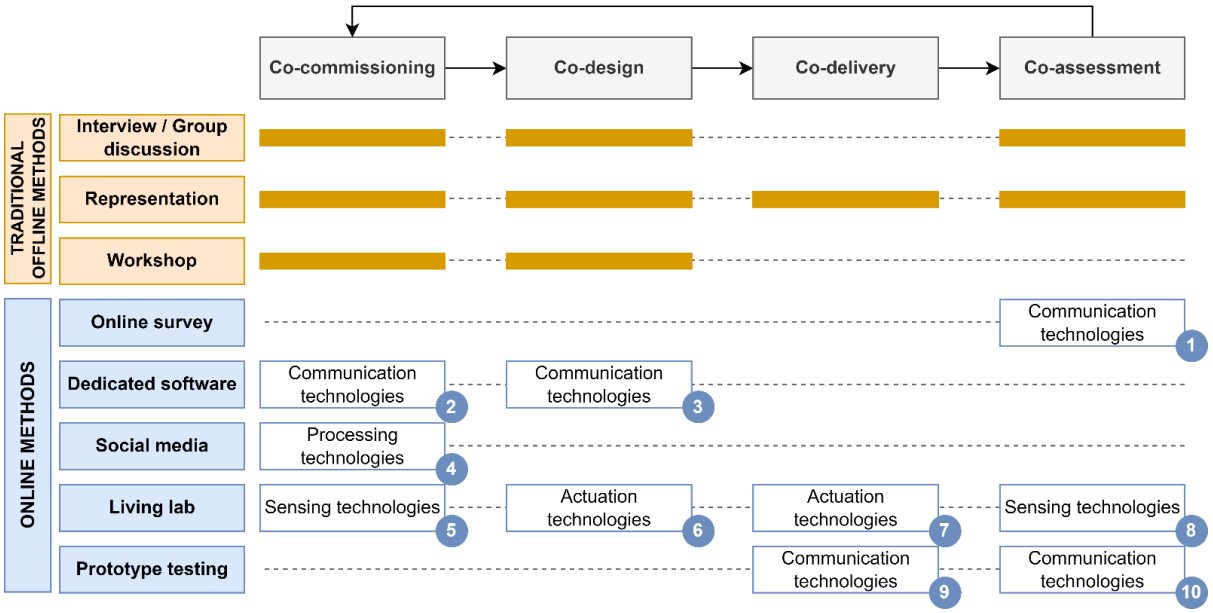


Figure 5: Best matches between co-creation stages and technologies.

Network-based model to visualize co-creation methods

Digital co-creation methods have a series of advantages, notably the scale of participation they enable. However, they do not provide a perfect solution to all co-creation challenges. Often, the combination of digital methods with traditional offline methods is a better approach to reach a broader audience and a higher rate of success. Yet, combining different online and offline methods is a complex task. This hybrid approach demands a good characterization of all elements involved in the implementation of the different methods. To this end, in the BeCoDigital project we created a simple graphical model to describe the different methods applied during their implementation phase (Bono Rossello et al., 2023).

The propose modeling approach is a so-called network-based model. Network models are composed of two kinds of elements: **nodes** and **edges**. **Nodes** are the agents composing the network, in this case the main elements of the co-creation process, namely stakeholders, tools or platforms. **Edges** represent the relations between agents.

Nodes. During the co-creation process, different stakeholders are involved: citizens, policy-makers, external stakeholders, and facilitators. In our model, we group stakeholders based on their roles in the co-creation process given that their role will define their importance within the co-creation. We define as nodes of our model any kind of stakeholder that generates, provides, or collects information. We define 4 types of nodes that represent different roles in the implementation of co-creation methods.

- **Target audience:** Group of citizens targeted by the co-creation process and its outcome. Depending on the goal of the co-creation, the target audience might represent the whole population or a specific part of it.
- **Participants:** Citizens who are directly involved in one or multiple stages of the co-creation process.
- **Facilitators:** Stakeholders who collect information and coordinate the co-creation process.

- **Platform/tool:** Elements of the co-creation process that receive, provide or analyze information but are not active in nature. This is the case of prototypes or artifacts that are generated as outcome of a given process.

Edges. The second element that constitutes our model concerns the connections between the different stakeholders. These connections are represented by edges in the model. In co-creation, there might exist different kinds of relations between the stakeholders. We defined the following types.

- **Communication:** Communication is seen as any sharing of information, such as a discussion between two stakeholders or interaction between stakeholders and platforms / tools.
- **Action:** Interactions that are directly related to the creation of a service or another stakeholder actions. Usually, this consists in processing information or selecting proposals.
- **Representation:** Unilateral connection that defines how accurately the attributes of the targeted citizens are represented by the direct participants.

In visual representations of the model, **edge** thickness varies to denote different connection strengths. **Nodes** are represented corresponding to stakeholders are represented by a circle. Its color varies according to the stakeholder in question. The target audience is colored orange, the participants are blue, and the facilitator appears green. Platforms / tools are depicted by red rectangles. As for edges, they are represented by a line of different style according to the type of connection they represent. Solid black lines represent communication, dashed black lines depict action relations, and orange dotted lines correspond to representation. Edge thickness varies to denote different connection strengths. Figure 6 showcases a generic example of this visualization.

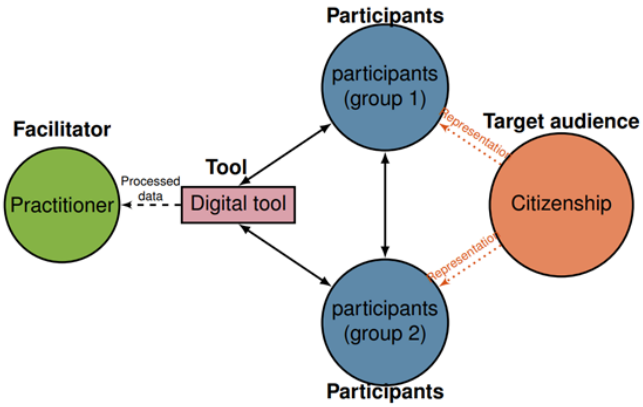


Figure 6: Generic visual representation of the network-based model.

Use of Artificial Intelligence in Co-creation

Among these new technologies it is acknowledged that Artificial Intelligence (AI) has the potential to not only increase the scale of participation, but also to empower partaking stakeholders by making participation more inclusive, more transparent and by improving its quality (van Noordt & Misuraca, 2022).

AI allows stakeholders to access and comprehend larger amounts of data, providing balance to the difference in resources between stakeholders and governments (Duberry, 2022). For example, recommender systems and chatbots simplify and support interactions in online platforms, making the

experience more efficient and easier for citizens (Ito, 2023). Summarizing, translating or providing feedback are other simpler ways AI can improve co-creation by equalizing the difference in cognitive capacities across participants (Anastasiou et al., n.d.). Aside from these benefits, there also exist greater risks in using AI in the public sector using more traditional technologies. AI-based recommenders can nudge discussions toward predefined topics (Pariser, 2011), and the lack of explainability and transparency in certain algorithmic processes might affect trust on the validity of these activities (Ehsan et al., 2021). In fact, AI is a broad term associated with several technologies that do not necessarily share the same characteristics and social impacts.

In the BeCoDigital project we studied the use of AI in co-creation from three different perspectives:

- *What can be done with AI?*
- *How to implement AI in co-creation?*

This part of our research aims to shed light on the current and potential uses of AI in co-creation. We focus mostly on online dedicated platforms (Gil et al., 2019; Simonofski et al., 2019). These platforms are present in different stages of co-creation and are a perfect example of technology bringing challenges to co-creation that could be tackled by using AI.

AI is a term that encompasses a large number of technologies (e.g., machine learning, NLP, chatbots, etc.). To provide a more practical approach to the role of AI in co-creation, this section focuses on characterizing the use of AI in co-creation based on its role (helping or replacing the human) and its scope (at the individual or collective level). Then, based on the different types listed, this characterization can guide the choice of the AI technologies that could fit best those conditions.

We developed a typology of potential uses of AI in online dedicated platforms supporting co-creation. These platforms allow stakeholders to formulate and react to contributions, usually presented in the form of ideas related to new or existing policies or services. The typology is defined by two main dimensions.

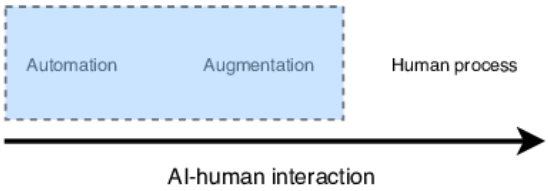


Figure 7: AI-human interaction spectrum and the selected range in this work

The first dimension, **AI-human interaction**, considers the share in control and influence between human and AI while performing a given task, going from fully automated to human based. We characterize the role of AI under the definition of the task being enhanced. For instance, the classification of contributions can be fully *automated* by an AI system if the process is fully AI-driven. On the other hand, if classifying contributions is part of a larger task evaluating the sentiments of

citizens, this latter task would be *augmented*, rather than fully automated, by the AI if most of its remaining steps are carried out by the human. The two envisioned scenarios can be summarized as follows.

Automation. The task is fully automated by the AI with no human intervention (Johnson et al., 2022).

Example: The topic classification of contributions, e.g., (Romberg & Escher, 2022), where the classification task is completely automated and carried out by a Natural Language Processing (NLP) algorithm.

Augmentation. The task performance of the human is improved thanks to the collaboration with the AI (Johnson et al., 2022).

Example: The AI-based argumentative feedback for citizens presented by (Borchers et al., 2023). This AI tool evaluates contributions from citizens based on how well they address certain topics in their text. Thanks to this analysis, citizens can edit their contributions, improving the quality of their text.

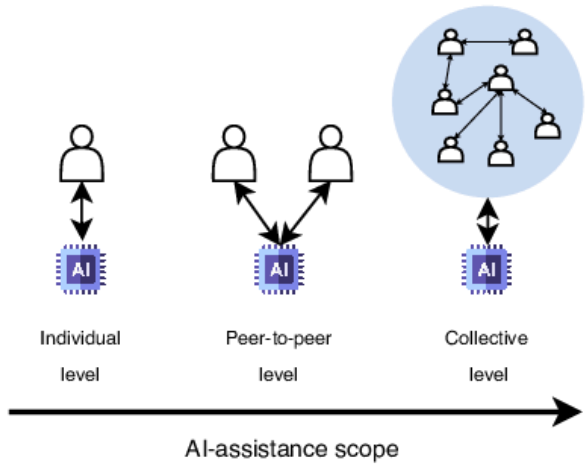


Figure 8: AI-assistance scope spectrum.

The second dimension of the typology, **AI-assistance scope**, is associated to the level of granularity at which the AI solution is implemented. This dimension has the following as possible values.

Individual level. The AI system affects and interacts with an individual participant, enhancing their participation at a cognitive or informational level.

Example: The previously mentioned feedback system from (Borchers et al., 2023) uses individual information in their assessment and improves the individual's contribution of each citizen.

Peer-to-peer level. The AI system affects and interacts with multiple individuals in one way or another based on their individual needs and information. It focuses on improving the interaction and communication between stakeholders (e.g., citizen-to-citizen interaction), or between stakeholders and the organizers of the co-creation (e.g., citizen-to-government).

Example: Recommender systems (Egger & Yu, 2022) connect different users by comparing their individual information.

Collective level. The AI system affects and interacts with the co-creation process as a whole. It focuses on the global outcome of the collaboration.

Example: The use of network analysis to represent ideation dynamics in an ideation process, as the information and outcomes of these analysis concern the overall process (Shin & Rask, 2021).

The typology provides six ideal types of AI solutions summarized in the following table. We delve into more detail within each type and discuss the opportunities and risks they involve.

Table 1: Typology describing AI use in digital co-creation

	Individual level	Peer-to-peer level	Collective level
Automation	**Processing tools** Processing information that facilitates the individual tasks of the participants during the participatory process *Example:* Topic analysis *Implementation:* Summarize a selected proposal	**Recommendation tools** Generating potential links in terms of proposals or users *Example: Recommender systems Implementation:* Find similar proposals/similar users	**Analysis tools** Generating quantitative indicators related to the outcome of the co-creation process *Example:* Network analysis *Implementation:* Identify topics and key contributions
Augmentation	**Individualized feedback** AI interaction to improve the performance, motivation of knowledge of individuals *Example:* Individual performance feedback *Implementation:* Feedback on the suitability of a submitted idea	**Enriching feedback** AI interaction to trigger knowledge relations and enrich the individual and collective inputs *Example: Bounder spanner recommendations Implementation:* Provide relations with other potential topics	**Collective feedback** AI interaction based on processed collective data to optimize the overall participatory process *Example: Feedback based on ideational dynamics Implementation:* Feedback to develop more current ideas or move toward unexplored topics

PROCESSING TOOLS

Processing tools can be seen as any AI-based solution that automates tasks, such as the processing or generation of information, at the level of individual participants. The task associated with the AI (e.g., the labelling of the citizen's proposals or summary of text) is fully automated.

One of the main issues of digital co-creation platforms is information overload, where large-scale participation involves a huge number of contributions to process (Davies et al., 2021). As a result, access to fellow participants' contributions can be complicated and discouraging. In this context, processing tools can be very practical, as the main goal of these systems is to process and accommodate high amounts of contributions. The use of Natural Language Processing (NLP)

techniques and chatbots have emerged as ideal instances of AI technologies for this kind of tasks (Cortes-Cediel et al., 2020).

NLP is a technology that has demonstrated to be very effective in processing and summarizing unstructured text contributions (Egger & Yu, 2022). NLP can be used to label or summarize participants' contributions (Arana-Catania et al., 2021; Romberg & Escher, 2022). Chatbots can be part of these automated tasks by providing a simpler interface with the NLP algorithm.

Opportunities: Processing tools might help individual stakeholders to navigate vast amounts of information, balancing the disparity in the access to resources across stakeholders (Savaget et al., 2019). Additionally, individualized approaches relying on individual data can be better evaluated and regulated (Gupta & Woolley, 2021).

Risks: Processing tools might be potentially dangerous depending on the type of technique used (Sarker, 2022). Rule-based chatbots, i.e., chatbots that have a limited and regulated range of instances, are less performing than their machine learning counterparts but can be programmed to ensure correct and legal answers (Følstad et al., 2023). Contrariwise, generative AI chatbots have shown an enormous potential, providing very personalized and human-like interactions, but they might present symptoms of hallucination or bias in their answers. This balance between performance and robustness is an important aspect to evaluate before the implementation of this type of AI-driven solutions.

RECOMMENDER TOOLS

Recommender tools automatize tasks involving several participants, while keeping the focus of their actions on the individual needs of each participant. This type of AI systems is commonly associated with automatically creating connections between participants or making links between subjects.

During deliberation or ideation activities, automated processes can be used to connect participants and contributions (Arana-Catania et al., 2021), or to help participants to connect with fellow participants having similar opinions (Romberg & Escher, 2022).

Opportunities: Recommender tools may have a great impact in co-creation as they help to overcome information overload (Chun et al., 2012) and the lack of real-time discussions (Aitamurto et al., 2017). The generation of connections between similar ideas and users might help to enrich debates and to optimize the share of opinion and knowledge.

Risks: The use of recommender tools has shown a tendency for filter bubbles and eco-chambers (Pariser, 2011). That is filtering information based on personal characteristics and preferences and thus isolating citizens from different perspectives and opinions. Moreover, recommender systems heavily rely on how they are tuned. As such, the implementation of recommender systems must be transparent and properly designed (Ehsan et al., 2021).

ANALYSIS TOOLS

Analysis tools are associated with tasks that affect the overall co-creation process and all participants.

In an example of practical implementation, (Amarasinghe et al., 2021) use network modeling to characterize the ideation process in citizen science, identifying main contributors and important ideas thanks to the network topology. In co-creation, these indicators can also be used to compare the evolution of different aspects of the process and to envision real-time actions to improve the quality of the activity. For instance, to monitor the dynamics of a participatory budgeting process (Shin & Rask, 2021), facilitating the evaluation of its outcomes.

For example, (Koch et al., 2013) have studied the case of the Aufbruch Bayern platform, which allows citizens to post and react to ideas for the city. To better understand how citizens interact on this platform, the authors have classified them according to their level of activity. For example, passive users have low activity on the platform, idea generators contribute many ideas but rarely interact with others' contributions. Motivators contribute few new ideas but frequently react to others' contributions. Then, a network visualization was built to show interactions between users (i.e., two users interacting means that one reacted to the other's contribution). The weekly evolution shows how the platform grows over time.

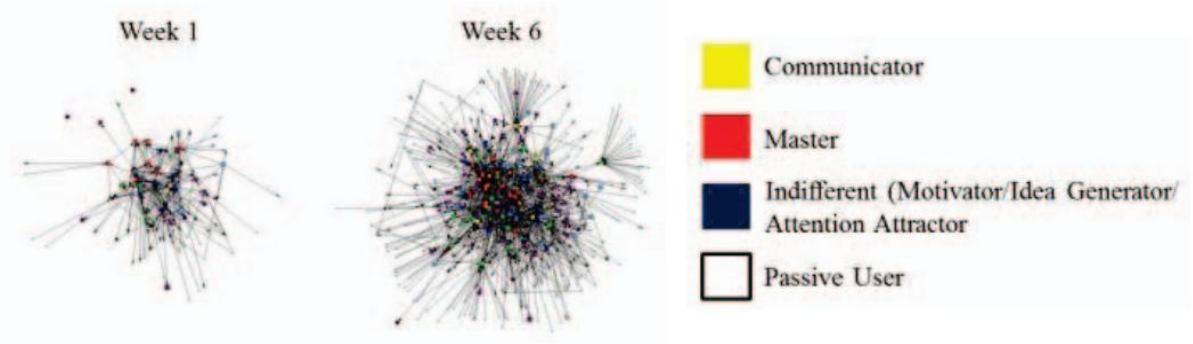


Figure 9: Analysis of the activity on a co-creation platform (from (Koch et al., 2013)).

Opportunities: Analysis tools could provide stakeholders with a way to understand and process more comprehensive data without the intervention and processing from the government. This new paradigm would help stakeholders to have a more active involvement and knowledge of the overall process (Havrda, 2020), by relying less on the resources directly provided by the co-creation organizer. This could bring more autonomy and balance the power disparities during the co-creation process.

Risks: Analysis tools work with collective indicators generating global information that may fail to provide detailed and particularized information of all different stakeholders. In this sense, these tools that provide a synaptic description of a given process can promote the masking of minorities and reduce the diversity of stakeholders' input if they are too much relied on. As such, relying excessively on this kind of approach could be counterproductive in terms of diversity of inputs and participation.

INDIVIDUALIZED FEEDBACK

Individualized feedback groups AI solutions in which there is a collaboration between the human and the AI to carry out a given task at an individual level.

Within the co-creation field, several chatbot solutions aiming at this augmentation of the individual experience have been proposed (Androutsopoulou et al., 2019). For instance, (Borchers et al., 2023) provide an example of NLP approach which helps citizens to understand if a contribution fits into a given topic, augmenting the performance of the participants and resulting in a more elaborated argumentation during the discussion.

Opportunities: Individualized feedback can help stakeholders to improve and enhance their comprehension of given topics and provide them with the right tools to express their views. Based on the nature of these solutions, this approach also ensures that the output generated is supervised by the stakeholder, helping to improve trust and transparency in the use of AI (Molina & Sundar, 2022).

Risks: The supervised approach that individualized feedback solutions implement does not exclude them from inserting bias into the process or influencing the actions of participants (Barredo Ibanez et al., 2021). This influence, and any possible bias integrated during the design of the AI system, must be evaluated prior to the implementation.

ENRICHING FEEDBACK

Enriching feedback defines a type of AI solution that enhances tasks by interacting with several participants. This can be done in the form of information snippets or by directing participants toward certain discussions. Enriching feedback can help to enlarge the knowledge and scope of the contributions with less impact from algorithmic outcomes.

For example, (Wahl et al., 2022) use AI-generated stimuli from other perspectives to affect the idea outcome in innovation, providing early examples of these types of applications. (Siangliulue et al., 2016) use machine learning to create an interactive solution space that helps users to enhance the quality of their interventions.

Opportunities: Enriching feedback types of approaches could be used during the ideation or the co-delivery phase in a co-creation project. These AI systems could bring additional information and help to generate associations between participants.

Risks: Unfortunately, as in the case of individualized feedback, there is still the risk of enriching feedback tools biasing the outcome toward more common solutions, neglecting minority views on certain subjects. Precisely, the fact of not providing direct outcomes, but influencing the citizen's behavior, makes these approaches hard to evaluate and to measure their actual impact in discussions and interactions.

COLLECTIVE FEEDBACK

Collective feedback is a type of AI-based solution that helps to improve the overall performance of the co-creation activity by interacting with stakeholders and the co-creation organizers. This implies helping to use and comprehend collective outcomes of the different stages of co-creation. That is for instance to influence the collective behavior of participants, e.g., promoting certain topics that are being underdiscussed, so to improve some aspects of the service or policy being developed.

Works on AI and machine learning have explored how ideation dynamics evolve and in which way AI feedback can help to improve this overall process (No et al., 2017). Based on the computed novelty of contributions or the number of comments on certain topics, collective feedback systems encourage new contributions toward certain areas. Other approaches of collective feedback work as discussion support systems aiming at enhancing the consensus and integration of ideas during deliberation phases (Ito, 2023).

Opportunities: In co-creation, individual interests of stakeholders are sometimes hard to convey into more general and aligned ideas (Aitamurto, 2016). While more advanced concepts of collective feedback are not yet applied to co-creation, promising results can be seen in AI-based agents facilitating crowd discussions (Ito et al., 2022) or the use of moderation by AI (Molina & Sundar, 2022).

Risks: One of the reasons why collective feedback solutions are still very scarce is that collective indicators are very hard to define and might lead to bias from powerful stakeholders. The definition of global indicators must be co-evaluated to avoid power dynamics to affect the design of the AI algorithm.

Tailored uses of AI in co-creation projects

At this point, we have presented a typology of the potential types of AI solutions, what could be their implementation in co-creation and developed potential benefits and risks associated with these implementations. This section puts the typology into practice by mapping the types to the stages of co-creation based on the main mechanisms associated with them. Then, we assess the current use of AI in co-creation by using the typology as an evaluation tool.

The figure below displays a mapping of the different types of AI tools and the phases of co-creation processes. This mapping is not exhaustive, as other types could be associated with these phases, but it shows the best matches we identified between co-creation phases and types of AI implementations.

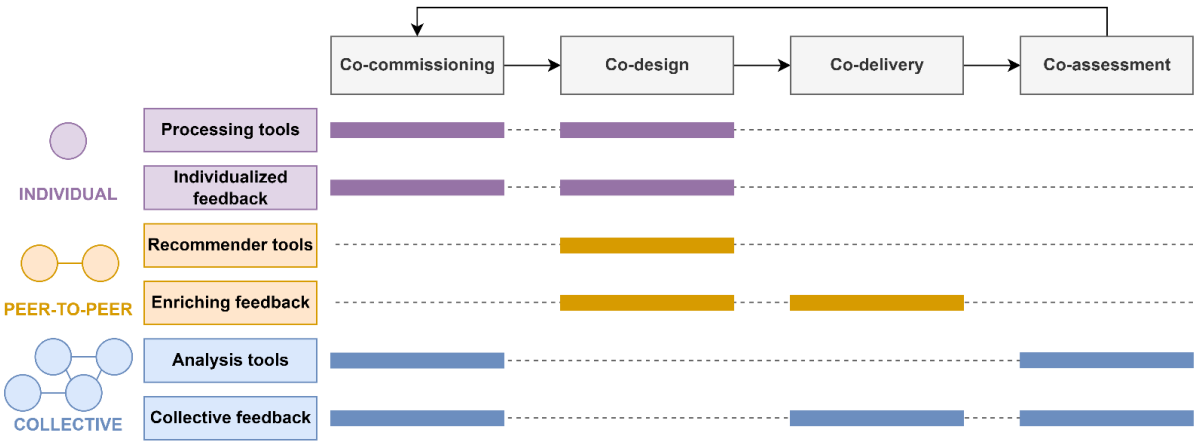


Figure 10: Best matches between co-creation stages and types of AI use.

Co-commissioning. The co-commissioning phase includes activities in which public and private actors consult on shared problems, mutual challenges or common tasks; identify problem-solving strategies and prioritize stakeholders, needs to address, outcomes to achieve, and resources to use.

This phase requires an efficient sharing and analysis of information by all stakeholders prior and posterior to their interventions. Stakeholders' contributions can be enhanced by individual AI tools to provide them with enough information about the problems being considered. This can be achieved by individual feedback in the form of online chatbots. In large scale projects, this phase can also benefit from automating individual tools, such as classification and summarizing of contributions, so the information being produced is easier to analyze and comprehend. Namely, the use of collective tools in the form of analysis tools could be particularly interesting as their outcomes could be provided to different stakeholders during this phase or to evaluate the results of different co-commissioning stages.

The type of collective feedback tools has also potential to be used during the co-commissioning phase. In that case, the augmentation aspect requires some further investigation so to evaluate how these tools can help the functioning of this collaborative process without steering the outcomes based on certain interests or masking minorities.

Co-design. The co-design phase represents the planning of the configuration and of the future execution of the service. During this phase the main mechanisms implemented are: (1) the consultation and ideation of service design elements, and (2) informing and equipping the stakeholders with the right tools for the decision-making (Linders, 2012). Each of these mechanisms can be enhanced differently by AI-based solutions.

During the consultation and ideation part, the main focus is on receiving feedback from the different stakeholders, while reinforcing their interactions to improve the quality of the final outcomes. Processing tools and individualized feedback are two different approaches to precisely provide information to the stakeholders regarding the current ideation topics and to enhance their contributions. Recommendation tools and enriching feedback might help to create more links between participants and to enhance the collaborative nature of this part of the co-creation process.

Informing the stakeholders and equipping them with the necessary knowledge is heavily associated with processing tools and analysis tools. Processing tools can make stakeholders aware of the essential

information during the co-design phase and, given the individual nature of this type of AI-driven solution, the information can be more personalized. Then, analysis tools can help to empower these stakeholders by providing also a broader knowledge of the co-design phase.

In both cases, the main goal is to enhance stakeholders' interaction and not to condition it to the AI-driven applications. This means improving interactions, not moving the stakeholders toward a more passive role by making them only a data provider.

Co-delivery. The co-delivery phase is focused on the execution of the service being co-created. This can be achieved via crowdsourcing or by the government acting as an integrative co-delivery ecosystem. In both cases, this phase requires the active involvement of stakeholders and the communication between them and the government institutions. This coordination, and the optimization of the resources and knowledge, are important aspects for the success of this part of the co-creation process, which could be improved using collectively focused AI solutions.

From an implementation point of view, during this phase of delivering the service, it is simpler to provide clearer guidelines for collective feedback solutions. This phase, focused on the execution of previously planned services, presents less problems in terms of potential bias generated by the AI than the co-design phase. During the co-design phase, bias from collectively driven AI systems can benefit more powerful stakeholders by steering deliberation towards certain topics. Contrariwise, during the co-delivery phase, the definition of the outcome has already been discussed. This makes the use of collective AI-based feedback AI more suitable at this stage.

Co-assessment. In the co-assessment phase, stakeholders participate in the assessment and monitoring of the service being delivered. This can be developed thanks to the use of citizen reporting and/or by relying on participatory open data approaches.

Thanks to the use of collective automated solutions, the participants can obtain more concise information to develop their assessment tasks in this phase. These solutions, such as network analysis, provide a good overview of the collective process and its outcomes. This makes it easier for the different stakeholders to provide more informed assessments. Having access to processed data and the evaluation of predefined outcomes can help to empower citizens to move from simple data providers to active participants of this phase.

Additionally, the use of collective AI-based feedback can make the experience of the co-assessment more efficient and simpler for the citizen. These tools augment collective tasks by providing useful information and guidance. For instance, these tools can provide access to indicators based on the interest of the citizen or to point towards elements of the co-creation process that could be of interest to that stakeholder.

ILLUSTRATIVE CASE 1: EMPTY HOMES TAX (VANCOUVER)

The Empty Homes Tax was a project from the City of Vancouver (Canada) created in 2018-2019 aimed to improve the housing affordability in the city. The idea was to create an annual tax associated to empty or under-utilized residential properties in order to generate a budget to spend on affordable housing projects.

To design projects where to invest this budget, the City of Vancouver used a digital platform developed by Go Vocal (formerly CitizenLab) to collect potential project ideas from citizens. The online platform allowed citizens to post, like, and comment on ideas regarding new housing projects. These ideas were to be summarized and shared with the city council.

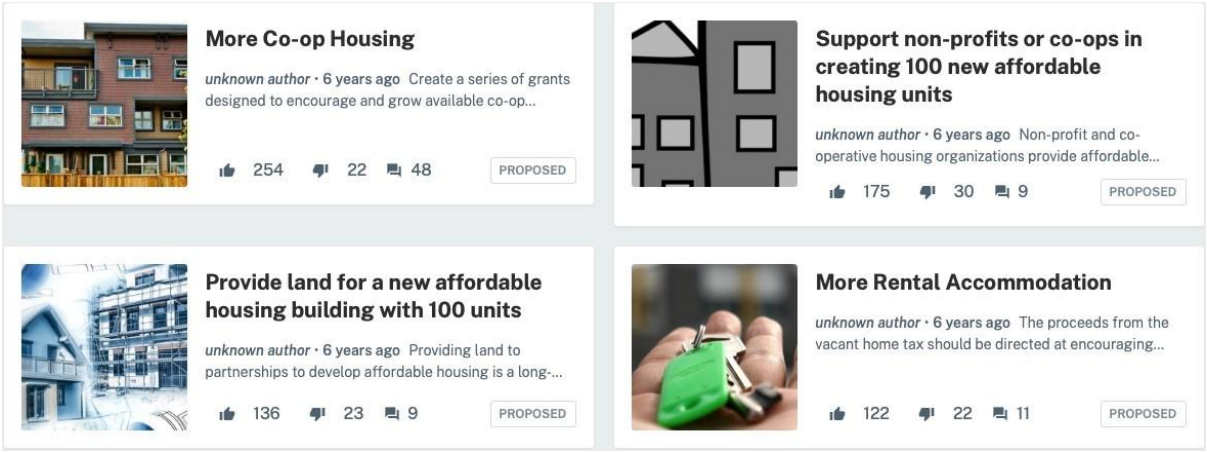


Figure 11: Illustration of the platform used in the Empty Homes Tax case.

Given the amount of data being generated and processed, the platform incorporated the following AI solutions (based on NLP algorithms) to better process the proposals:

- *Classification of proposals (processing tool):* Each input was added to one or more classes of proposals.
- *Similarity (analysis tool):* Different idea proposals got compared based on the words used. This allowed grouping proposals, avoiding duplicates, and unveiling patterns.
- *Summarizing (processing tool):* Ideas submitted got automatically summarized to help in their analysis.

This is a good example of using an AI explicitly designed to support and augment the outcomes of ideation while trying to reduce the influence of the AI system in the ideation. The AI role is limited to facilitating the generation and analysis of the citizens' ideas. The less appealing aspect about this case is that the AI tools are mainly thought for the processing of the data from the city and practitioners' point of view, with no explicit goal of empowering the citizens via their use.

ILLUSTRATIVE CASE 2: BETTER REYKJAVIK

The Better Reykjavik platform was built using the Your Priorities web application, developed by the non-profit Iceland-based Citizens Foundation. Overall, Better Reykjavik is an online participatory social network that has hosted several citizen-government initiatives, such as the co-creation of the City's education policy in 2017.

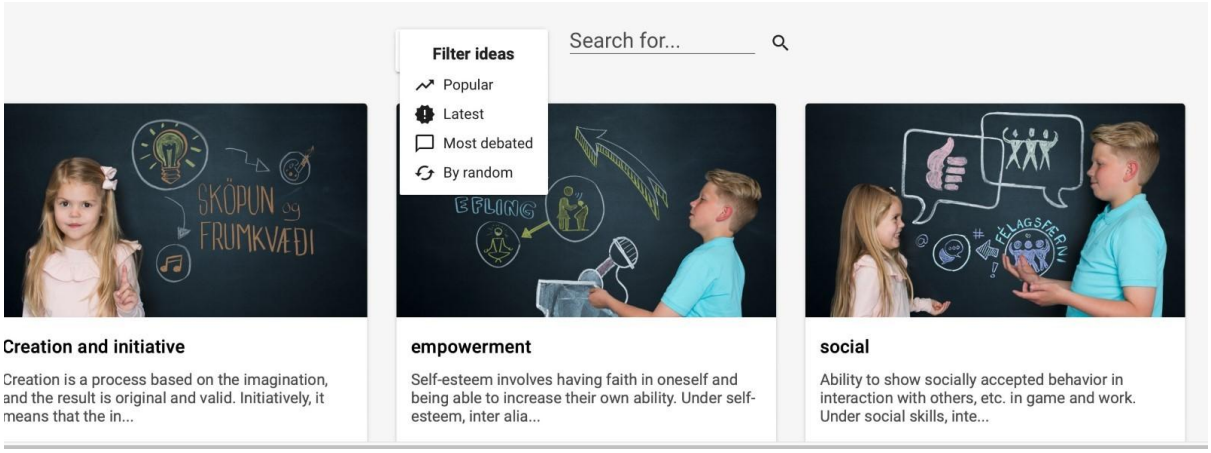


Figure 12: Illustration of the platform used in the Better Reykjavik case.

The digital and AI-based tools used in this platform have been updated several times. The AI-based solutions integrated to the platform are the following:

- *Machine Translations (processing tool):* Ideas and interactions can be translated to a large range of languages
- *Recommendations and Notifications (recommender tool*): Citizens get notifications and recommendations based on their posts.
- *Speech-to-Text (processing tool):* The platform provides a system to convert speech into text to the citizens' input.
- *Toxicity Detection (processing tool):* The ideas' platform disposes of a machine-based detector of toxicity and hate speech.
- *Cluster Analytics (analysis tool):* The data collected can be clustered based on some parameters chosen by the practitioners.
- GPT-4 powered chat interface (individualized feedback): Chatbot to improve the accessibility of the citizens to the platform.

Overall, this example provides sophisticated tools to enhance, primarily, ideation activities. An advantage of this example, mainly in terms of transparency, is the personalization of the recommendation and clustering systems, while all the AI-based algorithms are also available in open source. Both aspects help to transmit the idea of trust and transparency to the users. At a task level, the main difference with the Empty Homes Tax case is that some of the tools are also designed for improving the accessibility of citizens to these platforms and are not exclusively targeted for the co-creation organizers.

ILLUSTRATIVE CASE 3: WEBERPLATZ REDEVELOPMENT (ESSEN)

The city of Essen created a web platform to find a consensus among the diverse stakeholders regarding their needs and desires about the redevelopment of Weberplatz. To improve the understanding and comprehension of the architectural design and the impact of the square, the platform incorporates a 3D-Online and Augmented Reality (AR) model of the square.

By using an AR and 3D online approach throughout the project stages, the advantages and disadvantages of the project proposals can be explained in an interactive manner, thereby reducing

information asymmetries between stakeholders and improving overall decision making. More specifically the platform incorporated:

- 3D visualization.
- Interaction and notation directly into the platform.
- Visualization of the expected temperature and air current within the square.

Through the platform, ideas, hints, and interests can be digitally added directly to the model. Thanks to the use of AI processing tools all these elements are transformed into visualizations which help citizens to understand their impact in the project. This approach exemplifies a different way AI can be of help in these platforms. The analysis and processing of information is not only related to text but, as in this case, it can be used to provide better visualization and more practical information to citizens.

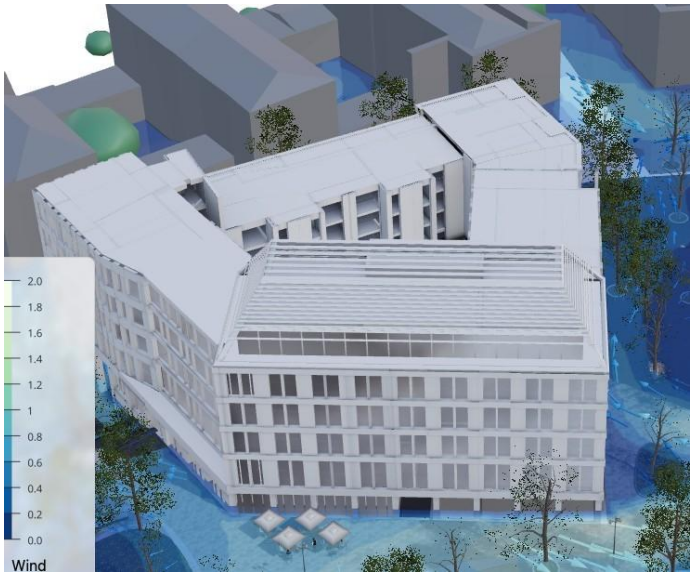


Figure 13: Illustration of the platform used in the Better Reykjavik case.

How to implement AI in co-creation? (design principles)

In this section we evaluate some illustrative cases of digital platforms and their use of AI solutions.

While most AI applications in co-creation are designed to handle very specific individual tasks (e.g., recommendation of others' ideas (Cantador et al., 2017)) their influence can be vast at a social level (König & Wenzelburger, 2020), influencing how citizens and stakeholders take part in the co-creation process. As such, it is not only about designing an AI system in online participation platforms that is functional, but it is crucial to consider the social relations in which this system is embedded (Ehsan et al., 2021).

We provide guidelines and principles on how to build an overall AI architecture for dedicated online platforms taking into account the co-creation process that these platforms support (Poblet & Plaza, n.d.). We define an architecture as the set of structures and systems that compose the different AI-driven functionalities. With our design principles we aim to provide guidelines regarding the main

elements that should be part of these structures, and their essential functionalities in the context of co-creation.

We can group the principles into two main sets. First, a set of principles associated to **the context and the objectives of the platform**, where the principle of Purpose-driven architecture (DP1) is realized by the principles of multilevel structure (DP2) and the dynamic allocation of AI actions (DP5). Then, a set related to the **participants and their relationship with AI**, which includes the principle of communication and transparency (DP3) being associated with the principle of human power control (DP6) and the principle of cognitive and informative balance (DP7). Lastly, the principle of collective and outcome monitoring (DP4) acts as a link between the set of principles related to the context and the participants.

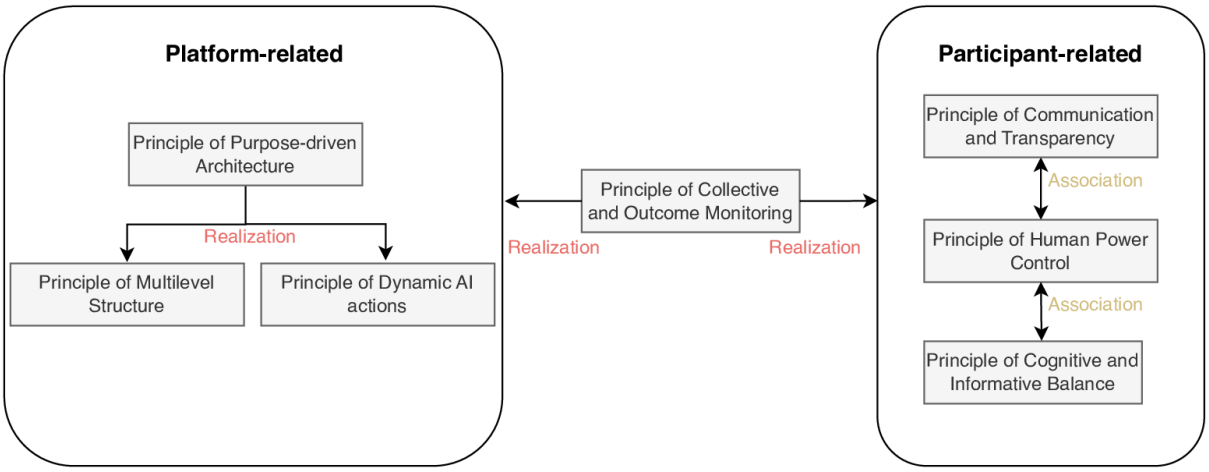


Figure 14: Set of design principles guiding the implementation of AI solutions in co-creation.

PRINCIPLE 1 - PRINCIPLE OF PURPOSE-DRIVEN ARCHITECTURE

This principle proposes to define the objective and attributes of a given task, and then selecting the adequate technical solution for that task.

According to this principle, the architecture of the digital co-creation platform and the AI tools must be defined based on the main goal of the co-creation (i.e., high quantity of ideas, promotion of discussions or solving complex issues) and the level of activity expected from the stakeholders. This also means being defined based on the type of contributions and interaction expected from stakeholders (e.g., comment on existing topics, submit new ideas, engage in discussions).

Example: Selection of a chatbot to improve the access and use of a platform by citizens. Chatbots powered by Large Language Models (LLMs) might have good performance and provide user-friendly interactions but the outcome from the chatbot might be false. Rule-based chatbots provide less friendly interfaces but the validity of their outcomes is more robust.

PRINCIPLE 2 - PRINCIPLE OF MULTILEVEL STRUCTURE

AI solutions have the capacity to improve the functioning of digital platforms at different levels: at the collective level (e.g., monitoring the number of ideas or the topics being discussed), at the peer-to-peer level (e.g., providing connections between participants) or at the individual level (enhancing individual contributions). By following this principle, the different uses of AI should be structured

based on different levels of application. This avoids conflicting actions (e.g., one system promoting interactions while other encourages individual contributions) or an information overload affecting citizens (e.g., providing several types of stimuli to participants rendering the experience overwhelming to citizens).

Example: Implementing a recommender system to better navigate contributions and a chatbot to help in the use of the platform. A potential issue would be a recommender system providing you with similar ideas, and a chatbot encouraging the user to provide new and unique contributions.

PRINCIPLE 3 - PRINCIPLE OF COMMUNICATION AND TRANSPARENCY

One of the main problems regarding the use of AI in the public sector, and many other domains, relates to the transparency and trust in the systems being deployed. This principle encourages active communication about the use and the objective of any AI-based application implemented in co-creation.

Example: The citizens should know if there are artificially generated proposals or if there is an algorithm selecting the content they see while navigating the platform.

PRINCIPLE 4 - PRINCIPLE OF COLLECTIVE AND OUTCOME MONITORING

Given the uncertain outcome of some AI solutions being implemented, the effects of the tools being used might not have been fully foreseen. This principle proposes the definition and monitoring meaningful collective indicators (KPI) related to the purpose of the platform, so to guide the actions carried out by the AI (e.g., coordinate participants' interactions or clustering of contributions). This is to avoid undesired outcomes such as polarization or minority under-representation. Ideally, these indicators should alert of any undesired outcome before its consequences are too important.

Example: In systems involving interactions of citizens with chatbots or recommending systems, monitor that the suggestions of these systems is not generating opinion bubbles or over-polarizing citizens.

PRINCIPLE 5 - PRINCIPLE OF DYNAMIC AI ACTIONS

The actions led by AI-driven systems (e.g., enabling communications, suggesting interactions or informing participants) that can be carried out at a given time are limited. Similarly to the second principle, this principle proposes to adapt them (not only in structure but in time) to the co-creation phase the type of project, so to avoid overwhelming citizens with excessive stimuli.

Example: During the co-commissioning phase, chatbots can help to show information about the topic of discussion or potential ideas. Then, this information becomes redundant for the citizen and the role of the chatbot should evolve accordingly.

PRINCIPLE 6 - PRINCIPLE OF HUMAN POWER CONTROL

This principle suggests that the platform must allow the supervision of the outcome of the AI systems by participants (e.g., validating automated tasks such as labelling of proposals). The participants should be allowed to supervise/modify any input inserted into the system coming from their data and/or actions. We can operationalize this principle in several manners, either by inserting the human in the loop (augmentation), e.g. using AI only as support in writing a proposal, or by allowing the human to validate the outcome of the task (automation), e.g. approving the automatic labelling of a proposal.

Example: Allow the validation by citizens in the automatic labelling of contributions or being able to switch off some features such as recommendations in the platform.

PRINCIPLE 7 - PRINCIPLE OF COGNITIVE AND INFORMATIVE BALANCE

In their interaction with stakeholders, AI systems should attempt to provide actions or information to balance the differences in knowledge and information between the different actors of the co-creation process. This means to provide help at the cognitive level (i.e., comprehend the data being generated and potential patterns) as well as the information level regarding the topics of discussion. A similar goal that can be achieved by following this principle is to help to reduce the information asymmetry between stakeholders and co-creation organizers (Duberry, 2022).

Example: Provide the same tools regarding clustering and analysis of contributions also to stakeholders (resources). Provide additional information regarding topics of discussion to stakeholders who are willing to participate.

4.3 Outcomes of digital co-creation

The third objective of this project focused on the outcomes of (digital) co-creation, and how these outcomes can be defined, affected, and navigated by practitioners. A special focus was on digitalization, and how the inclusion of digital tools and processes could affect outcomes.

Over the years, there have been a number of theories about the variety of possible outcomes of citizen participation, trying to pin down its many impacts. Irvin and Stansbury (2004), for instance, presented a rather pragmatic take: citizen participation can lead to better policy outcomes, they argued, but not without costs, coordination headaches, and the occasional splash of bias. Best et al. (2019) presented a nuanced view with both advantages and disadvantages such as cost and bias. Bentzen (2022) identified three main outcomes, namely innovation, ownership, and trust, underscored by continuous involvement but undermined by its discontinuity. Best et al. (2019) explored stakeholder salience's impact on value citizen participation, recognizing micro, meso, and macro-level gains and highlighting challenges in expectations and government reforms. Within the project, an outcome framework has been developed that determines and predicts co-creation outcomes. The main structure is based on the work of Voets et al. (2008), who developed a framework to characterize the performance of collaborative governance networks. Building on their work, we propose a refined framework that takes the best of prior contributions and organizes them across two core dimensions: levels of impact and types of outcomes.

The first important distinction when classifying outcomes is the level. The micro level refers to the individual participants in the citizen participation projects, such as individuals participating as citizens or service users, but also individuals participating as representatives of an organization such as an official of a public service organization (Best et al., 2019). Participation outcomes at this level affect how individuals think, act, and feel, whether they trust the system more (or less), feel empowered (or not), and whether they'll ever volunteer for citizen participation initiatives again. The meso level refers to the citizen participation initiative or network in which the individuals and organizations involved participate (Bentzen, 2022; Best et al, 2019). This is the structures that shape how participation happens. Bentzen (2022) and Best et al. (2019) both underscore that the design and functioning of this middle level strongly influences whether participation fizzles out or continues to grow. The macro level refers to the broader group of citizens, organizations and actors, including those who do not participate in the citizen participation project but are directly or indirectly affected by it. The macro level is where broader societal effects take shape, sometimes far from the original point of participation. It includes citizens who didn't participate but still experience consequences, institutions that adjust their policies accordingly, the broader political climate, and social narratives that either enhance or dismiss the value of engagement (Voets et al., 2008, Best et al, 2019). These levels are interconnected, with participation shaping and being shaped by individuals, governments, and broader societal structures. Citizen participation is a performative practice that not only reflects but also creates different forms of citizen involvement across different levels, influencing both direct participants and the wider public (Turnhout et al., 2010).

The second distinction is between outcome types, namely product outcomes, process outcomes, and institutional outcomes. Product outcomes refer to the substantive results of citizen participation, focusing on whether these initiatives achieve their intended goals and create effective solutions (Voets et al., 2008). While traditionally rooted in the New Public Management (NPM) perspective, which emphasizes efficiency and effectiveness in attaining measurable objectives (Dubnick, 2005; Voets et al., 2008), the relevance of product outcomes extends beyond this. Even as governance models evolve, product outcomes remain a core element because they assess whether citizen participation leads to tangible results and policy developments that better align with citizens' needs. These outcomes highlight the extent to which participation contributes to innovative and impactful policy solutions, ensuring that citizen participation generates meaningful results for both government institutions and the public. We distinguished six product outcomes, as visible in Table 2 below.

Table 2: Description of product outcomes from the outcome framework

	Product outcomes ***Which benefits does the digital co-creation initiative produce?***
Micro-level ***Focus on the outcomes relevant to participating service users.***	**Effectiveness** (To what extent have the individual needs and expectations of participating users been met through the co-creation initiative?) **Efficiency** (To what extent do participating users perceive the benefits of the co-creation initiative to exceed its costs?) **Innovation** (To what extent has the co-creation initiative introduced new ideas, solutions or methods that have benefited participating users?) **Learning** (To what extent have participating users acquired new knowledge, skills or insights through participation in the co-creation initiative?) **Personalization** (To what extent have individual users been able to customize or tailor the co-created solutions to their needs and preferences?)

	Satisfaction (To what extent are individual users satisfied with the solutions of the co-creation initiative?)
Meso-level ***Focus on the outcomes relevant to the co-creation initiative as a whole.***	**Effectiveness** (To what extent have the shared objectives or goals been achieved by the results of the co-creation initiative?) **Efficiency** (To what extent has the co-creation initiative led to an efficient or cost-saving solution?) **Innovation** (To what extent has the co-creation initiative introduced new ideas, solutions or methods that can be applied by policy makers?) **Learning** (To what extent did the co-creation initiative contribute to policy makers learning about the wants and needs of participants and citizens?) **Personalization** (To what extent did the co-creation initiative contribute to a solution that better fits the wants and needs of different groups?) **Satisfaction** (To what extent did the co-creation initiative contribute to satisfaction on the policy issue amongst participants?)
Macro-level ***Focus on the outcomes relevant to the broader community, policy sector or institutional context.***	**Effectiveness** (To what extent do external stakeholders and community members perceive the problem at hand to be addressed better?) **Efficiency** (To what extent has the co-creation initiative improved the efficiency of service delivery or resource allocation for the public service system?) **Innovation** (To what extent has the co-creation initiative introduced new ideas, solutions or methods that can benefit the public service system beyond the time or geographical limits of the co-creation initiative?) **Learning** (To what extent have the participating users, stakeholders, organizers and policy makers acquired new knowledge, skills or insights through the co-creation initiative that can be used beyond the initiative?) **Personalization** (To what extent did the co-creation initiative contribute to service delivery that better fits the wants and needs of different groups?) **Satisfaction** (To what extent are stakeholders and the broader community members satisfied with the outcomes and experiences of the co-creation initiative?)

While the product outcomes are useful in assessing the direct goals, there are other important dimensions in citizen participation outcomes as well. The process and institutional outcomes find their basis in the work by Hood (1991). The process outcomes help protect values such as fairness, honesty, and equality. How a process is organized and experienced, are, beyond outcomes in itself, also sometimes conditions for effective product and institutional outcomes (Hood 1991; Voets et al., 2008). Successful process outcomes are characterized by effective communication, transparent decision-making, and mechanisms that encourage mutual respect and trust among participants and organizers (Best et al., 2019). Importantly, the quality of the process is not just an outcome in itself but also a key factor in shaping participants' overall satisfaction and willingness to engage in future citizen participation initiatives. The six process outcomes can be seen in Table 1 (condensed) and Annex 1 (expanded).

Table 3: Description of process outcomes from the outcome framework

	Process outcomes ***How does the digital co-creation initiative proceed?***
Micro-level ***Focus on the outcomes relevant to participating service users.***	**Inclusiveness** (To what extent were all relevant participating users given equal opportunities to participate in the co-creation initiative?) **Transparency** (To what extent were participating users provided with sufficient information about the decision-making in the initiative?) **Legitimacy** (To what extent was the co-creation initiative perceived as legitimate by participating users?)

	Conflict resolution (To what extent were conflicts between participating users addressed and resolved in a fair and effective manner?) **Democratic accountability** (To what extent were the participating users held accountable for their ideas and actions in the initiative?) **Resource integration** (To what extent could participating users bring in valuable knowledge and experience?)
Meso-level ***Focus on the outcomes relevant to the co-creation initiative as a whole.***	**Inclusiveness** (To what extent have mechanisms and procedures been put in place to ensure that all relevant participants were involved and had equal opportunities?) **Transparency** (To what extent have mechanisms and procedures been put in place to provide participants with sufficient information about the co-creation process?) **Legitimacy** (To what extent were the used tools and methods considered legitimate?) **Conflict resolution** (To what extent have mechanisms and procedures been put in place to resolve conflicts and conflicting opinions during the co-creation process?) **Democratic accountability** (To what were decisions made democratically by the participating users?) **Resource integration** (To what extent were the resources of participating actors integrated in a way that contributed to achieving the shared objectives?)
Macro-level ***Focus on the outcomes relevant to the broader community, policy sector or institutional context.***	**Inclusiveness** (To what extent did the co-creation initiative contribute to making sure the voices, opinions and perspectives of different groups and stakeholders are included in the making of policy?) **Transparency** (To what extent did the co-creation initiative to a more transparency around policy creation and governmental decision making?) **Legitimacy** (To what extent did the solutions created in the co-creation initiative help provide a legitimate basis for decision making and policy creation?) **Conflict resolution** (To what extent had the co-creation initiative contributed to resolving conflicting opinions and views in the broader community?) **Democratic accountability** (To what extent did the co-creation initiative contribute to the government's ability to defend their decisions and policy on a democratic basis?) **Resource integration** (To what extent did the co-creation initiative contribute to the ability of citizens to contribute valuable knowledge and experience to policy making?)

The third outcome type is tied to the resilience and robustness of the system in which citizen participation takes place. By affecting the beliefs and behavior of participating users during and after citizen participation, the institutional outcomes can also be described as long-term effects or byproducts (Hood, 1991). Although institutional outcomes are often not pre-determined and intended, they are still important for the continuation of the system in which citizen participation takes place (Voets et al., 2008). The most important institutional outcome in citizen participation is often considered trust in government, as it serves as the foundation for resilience and robustness of the system, ensuring its continuation (Bentzen, 2022).

Table 4: Description of institutional outcomes from the outcome framework

	Institutional outcomes ***Does the project form robust, resilient and long lasting relationships?***
Micro-level ***Focus on the outcomes relevant to participating service users.***	**Reputation** (To what extent has the co-creation initiative improved the reputation of the organization or government that organized the co-creation initiative?) **Social cohesion** (To what extent do participating users feel a sense of commonality and shared purpose?) **Empowerment** (To what extent has the co-creation initiative improved the competence of participating users to navigate the legal and administrative system surrounding the policy problem?) **Trust** (To what extent has the level of trust between participating users increased during the co-creation initiative?)

	Solution ownership (To what extent do participating users and stakeholders feel a sense of ownership over the solutions developed through the co-creation initiative?) **Litigation avoidance** (To what extent has the co-creation initiative helped to avoid litigation between participating users and the government level that organized the co-creation initiative?)
Meso-level ***Focus on the outcomes relevant to the co-creation initiative as a whole.***	**Reputation** (To what extent has the way the co-creation initiative as organized improved the reputation of the organizing organization of government?) **Social cohesion** (To what extent have mechanisms and procedures been put in place to create a sense of commonality and shared purpose in the co-creation initiative?) **Empowerment** (To what extent has the co-creation initiative contributed participating users ability to defend their interest against the government) **Trust** (To what extent has the level of trust of participants in the policy issue or area impoved?) **Solution ownership** (To what extent have the users been informed on who owns the solutions and how they are going to be implemented?) **Litigation avoidance** (To what extent have mechanisms and procedures been put in place to avoid litigation or conflict between participating users and stakeholders?)
Macro-level ***Focus on the outcomes relevant to the broader community, policy sector or institutional context.***	**Reputation** (To what extent has the co-creation initiative improved the reputation of the broader policy sector or community?) **Social cohesion** (To what extent was the co-creation initiative able to promote social cohesion and community building in the broader community?) **Empowerment** (To what extent has the co-creation contributed to citizens ability to defend their interest against the government?) **Trust** (To what extent has the level of trust of the broader community and stakeholders towards the public service system or the co-creation network increased?) **Solution ownership** (To what extent do community members feel a sense of ownership over the broader policy issue and governmental decisions?) **Litigation avoidance** (To what extent has the co-creation initiative helped to avoid litigation and conflict between the government and citizens or stakeholders?)

The most important empirical insights were gathered through a large-scale survey of over 1000 Belgian respondents. This survey included a video-experiment, conjoint experiment, and likert-scale survey questions on how citizens value different outcomes.

The conjoint experiment looked into the preferences of four design characteristics: Participation channel, level, impact, and phase. Respondents were shows sets of randomized profiles, and were asked which co-creation profile they (1) would most like to participate in, (2) believed would lead to the best results, (3) believed would have the best organized process, and (4) believed would increase participants' trust in government the most.

When it comes to willingness to participate, respondents showed most willingness to participate in initiatives that were organized through a hybrid channel, at the local governance level, and covering the co-deciding phase. When it comes to outcomes, however, the strongest difference between willingness to participants and outcome expectations were visible in the channel: Respondents believed that the analogue channel would lead to better outcomes, and believed that hybrid participation would lead to the least positive outcomes overall. There were no strong visible differences between the different outcome dimensions.

The video-experiment showed a different effect of channels on outcomes. In this experiment, respondents were asked to estimate the outcomes after seeing multiple phases of co-creation in a video format. Respondents were divided into four groups: The first group saw a fully analogue participation process, the second group saw first two digital phases and then two analogue phases, the third group saw first two analogue phases and then two digital phases, and the fourth and last group saw a fully digital process. Respondents of the mixed channel groups and the digital group

anticipated the outcomes to be almost equal, while the analogue group anticipated significantly lower outcomes across all outcome dimensions. This result might indicate that due to the intensive nature of analogue participation, both in terms of time and effort, respondents view analogue participation as less positive when the co-creation process is long and covers multiple phases.

Lastly, the survey also included questions about how respondents overall prioritize different micro-level outcomes when participating in co-creation. Process outcomes appeared as the outcomes most important to citizens, but especially transparency. Product outcomes were overall the second most important outcome type, followed by institutional outcomes. However, efficiency, a product outcome, was considered least important overall.

Recommendations

Digital participation can offer various benefits to practitioners, such as scalability and inclusivity. Yet, it is important to be aware that digitalization may come at a price: participants may feel the results, process quality, and trust in government will not be as high in digital participation as it may be in analogue participation. This does not mean, however, that analogue participation is always viewed at better, as it requires more time and effort from participants. This may reflect in less participants willing to join a co-creation initiative, and may even lead to less positive outcomes when the participation process is long and covers multiple phases. Striking a balance between accessibility and depth can be challenging. Hybrid or mixed participation channels can help achieve this, provided the process remains guided by its main objective, whether that is strengthening citizen satisfaction and trust, or collecting input from a broad range of participants.

To ensure meaningful outcomes, practitioners should place a strong focus on process quality. This includes providing clear and accessible information, maintaining transparency throughout all stages of the process, and communicating explicitly about how citizens' input will be used. Participants should know in advance whether co-created outcomes will be binding decisions or advice to policy makers. Ultimately, success in co-creation depends less on the characteristics themselves, such as the channel used, but on the quality and openness of the initiative overall.

5. DISSEMINATION AND VALORISATION

Communication and dissemination plan

At the start of the project, a communication and dissemination plan has been created and approved. Throughout the project, this plan guided the strategy for dissemination and valorisation.

Website

From the beginning of the project on, a dedicated website has been developed to broadly communicate about the content, aims, and progress of the project.

Initially, the website was hosted by the University of Namur. Later on, the website was improved and re-located, from then on hosted by KULeuven. Throughout the project, the website was updated regularly. The final overview of available project content will be available on the website on December 31, 2025. Only a few manuscripts of an academic nature (e.g., the book chapters within both WP1 and WP2) will have to wait until the official publication of the book in the spring of 2026.

=> https://soc.kuleuven.be/io/becodigital

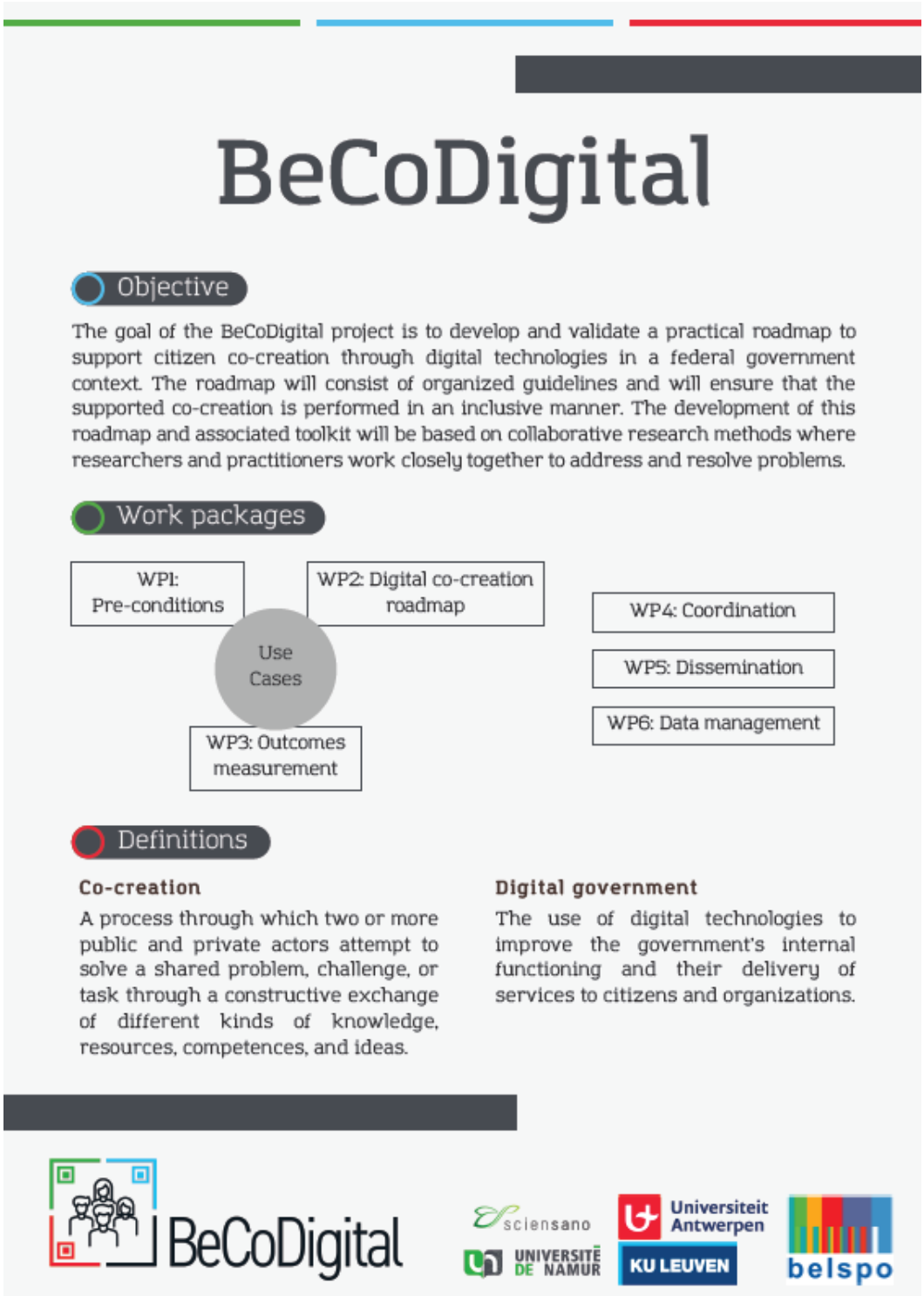
Social networks

Regular updates about the progress of the project and events are shared via LinkedIn: https://www.linkedin.com/company/93653408/

Awareness raising among stakeholders

Animated videos were created in French and Dutch with a visually descriptive presentation of co-creation. Initially, these vulgarization videos were created for the joint general public survey of WP1 and WP3. However, the network of contacts that have been established throughout BECODIGITAL also showed a lot of interest in these videos and, hence, their application might go beyond this project. The videos can be watched HERE.

Additionally, an explicative leaflet was created in French, Dutch, and English as a readily available support tool to present the objectives of BeCoDigital. This leaflet was distributed among Follow-Up Committee members and participants of international conferences (e.g. at the Smart City Expo 2024 in Barcelona*).* The English version of the leaflet can be found below.


BeCoDigital
Objective
The goal of the BeCoDigital project is to develop and validate a practical roadmap to support citizen co-creation through digital technologies in a federal government context. The roadmap will consist of organized guidelines and will ensure that the supported co-creation is performed in an inclusive manner. The development of this roadmap and associated toolkit will be based on collaborative research methods where researchers and practitioners work closely together to address and resolve problems.
Work packages
WP1: Pre-conditions
WP2: Digital co-creation roadmap
Use Cases
WP3: Outcomes measurement
WP4: Coordination
WP5: Dissemination
WP6: Data management
Definitions
Co-creation
A process through which two or more public and private actors attempt to solve a shared problem, challenge, or task through a constructive exchange of different kinds of knowledge, resources, competences, and ideas.
Digital government
The use of digital technologies to improve the government's internal functioning and their delivery of services to citizens and organizations.
BeCoDigital
sciensano
UNIVERSITÉ DE NAMUR
Universiteit Antwerpen
KU LEUVEN
belspo

Courses

Several materials and insights of the project have been integrated into lecture notes for courses. A few examples are:

- Integration of WP1 material, such as an example of a scientific problem statement, in the lecture notes of the bachelor course "Introduction to Political Science Research" and the master course "Integrated Research Seminar" at KU Leuven.
- Presentation regarding the use of AI in co-creation during the master course "Actualités en data science" at UNamur.
- Integration of the insights from WP2 regarding AI-based typology and design principles in the lecture notes of the master course "Emerging technologies for Smart Management" at UNamur.
- Integration of the results from WP2 (AI technologies for co-creation) in the course "Mettre en œuvre la transformation numérique des services publics"

Support for decision making

Throughout the project, the team has provided the following relevant support to decision-making:

WP1

WP1 delivers insights on when to use co-creation, as well as on factors influencing citizens' willingness to participate in co-creation. This informs organizers on how to act to maximize participation.

WP1's Baseline Measurement provides support for decision-making through its analytical framework, guiding practitioners in organizing digital co-creation initiatives and selecting AI-enhanced tools for stakeholder engagement. The framework allows practitioners to contemplate (a) organizing modalities, (b) stakeholders to be involved and (c) the extent of their involvement (in different stages of a digital co-creation initiative). Based on these decisions, digital tools or applications—utilizing one or multiple type(s) of AI enhancement—can be selected to support particular types of stakeholder involvement. Moreover, specific strategies to get stakeholders to participate and keep them engaged might be considered depending on the characteristics of the stakeholder group or target audience.

The policy report (incl. Engagement Monitoring Instrument), presented as a direct outcome of WP1, is devised in such a way that it builds up to a list of practical recommendations for the organization of digital citizen participation and, hence, future decision-making processes that precede the actual organization of such initiatives. Ideally, sufficient attention and preparation efforts are devoted to how the initiative will be structured, what its outlines, contours and objectives will be, internal coordination, communication and follow-up structures, as well as feasible timelines to make this happen. The insights from the policy report can make a practical contribution to this.

WP2

WP2 provides a set of co-creation methods and compares each of them on several characteristics. This informs organizers about the different possible methods and helps them decide which one(s) to choose depending on whether they prioritize, e.g., scalability or output clarity.

Secondly, the typology for AI-enhanced online ideation leads to types of AI tools to include and deploy in different types and set-ups of digital co-creation. This approach allows practitioners and developers to consider the use of AI tools based on their requirements and the type of task instead of seeing AI as a unique concept. The typology provides a characterization of the impact of the AI solution implemented, e.g., degree of automation or scope of application, such that the right technology or the decision regarding whether to use AI or not within a given part of the process, can be better formalized.

Finally, WP2 offers two useful items of output that can support decision-making:

- The roadmap: an extensive document that guides practitioners in detail through the different phases of co-creation as well as citizens' perceptions, methods, and outcomes.
- The online toolkit: a shorter and more interactive resource that serves as an easy-access guide to the use of technologies and digital methods in co-creation.

WP3

The results of WP3 provide a practical tool for practitioners to use throughout the co-creation process: The outcome framework. Additionally, practical recommendations for organizers have been developed on how outcomes are affected by digitalization and other design changes, based on citizen perceptions.

Presentations at events

Throughout the project, the members of the BeCoDigital team participated in many events:

Event name	Activity	Date	Notes
Open Meeting of the IIAS Study Group on Coproduction of Public Services	Presentation	May 11-12, 2023	N/A
International Conference on Research Challenges in Information Science (RCIS)	Presentation	May 23-26, 2023	Presentation of the BeCoDigital project and of the conference paper on idea browsing
International Conference on Digital Government Research (DGO)	Presentation	July 11-14, 2023	Presentation of the conference paper on Open Government Data based value proposition tools
International Conference on Electronic Government (EGOV)	Presentation	September 04-07, 2023	Presentation of the conference paper on the co-creation modelling framework
Cycles de conférences en actualité en data science	Presentation	November 30, 2023	Presentation on the upcoming conference paper about the typology for AI-

			enhanced online ideation
COPRO Conference	Presentation of a paper outlining part of the work done in WP1	May 28-29, 2024	COPRO is a scientific conference on the Co-Production of Public Services
BeGeo Conference	Presentation of the results concerning WP2 and the use of AI in co-creation	March 19, 2024	BeGeo is a Belgian conference related to the use of Geo-intelligence for a more sustainable future
Conference of the European Group for Public Administration	Presentation of a paper outlining part of the work done in WP3	June 13-14, 2024	The paper presents the conjoint and co-creation outcomes, which tested and applied the outcome framework
EGOV Conference	Presentation of a poster outlining the work on AI done in WP2	September 1-5, 2024	EGOV is an international scientific conference dedicated to the broader areas of e-Government and e-Democracy
Politicologen Etmaal Conference	Presentation of a paper outlining part of the work done in WP1 and WP3	September 3-6, 2024	The paper presents the conjoint and citizens' willingness to participate in co-creation
DDAI Workshop	Presentation outlining the work on AI done in WP2	September 20, 2024	Intercultural Workshop on Digital Democracy & AI co-organized by Gdańsk University of Technology and Kyoto University
Annual meeting of the SCDI	Presentation outlining part of the work on AI done in WP2	November 5, 2024	The SCDI regroups researchers from Umeå, Göteborg, and Stockholm focusing on digital innovation in the private and public sector
Hawaii International Conference on System Sciences (HICSS)	Conference presentations	January 7-10, 2025	Presentation of multiple submitted conference papers (published as proceedings) during the annual (edition 58) HICSS conference.
Netherlands Institute of Governance Conference (NIG)	Presentation	February 7, 2025	Presentation of conference paper
Conference International Research Society for Public Management (IRSPM)	Presentation	April 9, 2025	Presentation of conference paper

Vivre la ville	Presentation outlining part of the work on AI done in WP2	June 13, 2025	Regional conference gathering citizens, practitioners, and researchers from Wallonia
Politicologen Etmaal	Presentation	June 13, 2025	Presentation of conference paper
Conference International Research Society for Public Management (IRSPM)	Presentation	August 27, 2025	Presentation of conference paper
Athens Conference for European Group for Public Administration (EGPA)	Presentation	September 4, 2025	Presentation of conference paper

Follow-up committee meetings

During the course of the project, five meetings with the members of the Follow-up committee were organised:

- April 24, 2023 (BELSPO headquarters, hybrid format)
- October 10, 2023 (online)
- March 25, 2024 (BELSPO headquarters, hybrid format)
- September 30, 2024 (BELSPO headquarters, hybrid format)
- February 3, 2025 (BELSPO headquarters, hybrid format)

These meetings always generated very valuable insights on the progress of the research, and the researchers included this feedback as much as possible in the next steps of the project.

Feedback was collected in response to presentations about the research progress but also in more active ways of deliberating, such as moderated group discussions, short Qualtrics surveys, interactive Miro boards, or workshops.

To some meetings, additional stakeholders, such as federal, regional and local actors who offered insight into their co-creation projects as part of the Baseline Measurement interviews, were invited to participate.

BeCoDigital Final event

On December 9, 2025, the project's closing event was organised online to present and discuss the final results and recommendations and to reflect on future steps and opportunities.

6. PUBLICATIONS

Bono Rossello, Nicolas; Simonofski, Anthony; Clarinval, Antoine; Castiaux, Annick (2024). A Typology for AI-enhanced Online Ideation: Application to Digital Participation Platforms. Hawaii International Conference on System Sciences (HICCS) 2024, 57, pp. 1850-1859.

Bono Rossello, Nicolas; Simonofski, Anthony; Castiaux, Annick (2025). Artificial intelligence for digital citizen participation: Design principles for a collective intelligence architecture. Government Information Quarterly, 42(2), pp. 1-19.

Bono Rossello, Nicolas; Simonofski, Anthony; Castiaux, Annick (2026 - Awaiting book publication). Artificial intelligence for co-production: existing solutions and research directions (pp. 48-77) in Taco Brandsen, Ina Radtke, Paula Rodriguez Müller & Trui Steen (eds.), Digital Co-Production of Public Services: Citizens, Challenges and Cases. Edward Elgar.

Clarinval, Antoine; Crusoe, Jonathan; Simonofski, Anthony (2025). Open Government Data for Citizen Participation: Where is the Added-Value? Hawaii International Conference on System Sciences (HICCS) 2025, 58, pp. 2189-2198.

Coenen, Laurien (2026 - Awaiting book publication). Mapping pre-conditions for (sustained) participation in digital co-production (pp. 24-46) in Taco Brandsen, Ina Radtke, Paula Rodriguez Müller & Trui Steen (eds.), Digital Co-Production of Public Services: Citizens, Challenges and Cases. Edward Elgar.

Rossello, Nicolas Bono; Simonofski, Anthony; Rossello, Bono Lluc; Castiaux, Annick (2025). Integrating Generative AI into Information Systems Research: A Framework for Synthetic Data Evaluation. Hawaii International Conference on System Sciences (HICCS) 2025, 58, pp. 7195-7204.

Simonofski, Anthony; Nikiforova, Anastasija; Lnenicka, Martin; Bono Rossello, Nicolas (2025). Artificial Intelligence as a Catalyzer for Open Government Data Ecosystems: A Typological Theory Approach. Hawaii International Conference on System Sciences (HICCS) 2025, 58, pp. 2176-2185.

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REFERENCES

Aitamurto, T Landemore, H., & Saldivar Galli, J. (2017). Unmasking the crowd: Participants' motivation factors, expectations, and profile in a crowdsourced law reform. In *Information, Communication & Society* (Vol. 20, Issue 8, pp. 1239–1260).

Amarasinghe, I., Manske, S., Hoppe, H. U., Santos, P., & Hernández-Leo, D. (2021). Using Network Analysis to Characterize Participation and Interaction in a Citizen Science Online Community. In *Collaboration Technologies and Social Computing* (Vol. 12856, pp. 67–82). Springer International Publishing. https://link.springer.com/10.1007/978-3-030-85071-5_5

Androutsopoulou, A., Karacapilidis, N., Loukis, E., & Charalabidis, Y. (2019). Transforming the communication between citizens and government through AI-guided chatbots. *Government Information Quarterly*, *36*(2), 358–367. https://doi.org/10.1016/j.giq.2018.10.001

Anthopoulos, L. G., Siozos, P., & Tsoukalas, I. A. (2007). Applying participatory design and collaboration in digital public services for discovering and re-designing e-Government services. *Government Information Quarterly*, *24*(2), 353–376.

Arana-Catania, M., Lier, F.-A. V., Procter, R., Tkachenko, N., He, Y., Zubiaga, A., & Liakata, M. (2021). Citizen Participation and Machine Learning for a Better Democracy. In *Digital Government: Research and Practice* (Vol. 2, Issue 3, pp. 1–22). https://doi.org/10.1145/3452118

Axelsson, K., Melin, U., & Lindgren, I. (2010). Exploring the importance of citizen participation and involvement in e-government projects: Practice, incentives, and organization. In *Transforming Government: People, Process and Policy* (Vol. 4, Issue 4, pp. 299–321). https://doi.org/10.1108/17506161011081309

Bailey, K. D. (1994). *Typologies and taxonomies: An introduction to classification techniques*. Sage Publications.

Barredo Ibanez, D., Molina Rodriguez-Navas, P., Medranda Morales, N. J., & Rodriguez Breijo, V. (2021). Health transparency and communication on the government websites of Ibero-American countries: The cases of Chile, Colombia, Ecuador, and Spain. In *International Journal of Environmental Research and Public Health* (Vol. 18, Issue 12, p. [1-16]). https://doi.org/10.3390/ijerph18126222

Becker, F., Siemon, D., Department of Software Engineering LUT University Finland, Robra-Bissantz, S., & Business Information Systems Technische Universität Braunschweig Germany. (2022). Smart Participation Design: Prescriptive Knowledge for Bottom-Up Participation. *Communications of the Association for Information Systems*, *51*(1), 484–508. https://doi.org/10.17705/1CAIS.05121

Berntzen, L., & Johannessen, M. R. (2016). The Role of Citizen Participation in Municipal Smart City Projects: Lessons Learned from Norway. In J. R. Gil-Garcia, T. A. Pardo, & T. Nam (Eds.), *Smarter as the New Urban Agenda* (Vol. 11, pp. 299–314). Springer International Publishing. https://doi.org/10.1007/978-3-319-17620-8_16

Blaschke, M., Haki, K., Aier, S., & Winter, R. (2019). *Taxonomy of Digital Platforms: A Platform Architecture Perspective*. 14th International Conference on Wirtschaftsinformatik, Siegen, Germany.

Bonina, C., & Eaton, B. (2020). Cultivating open government data platform ecosystems through governance: Lessons from Buenos Aires, Mexico City and Montevideo. In *Government Information Quarterly* (Vol. 37, Issue 3, p. 101479). https://doi.org/10.1016/j.giq.2020.101479

Bono Rossello, N., Castiaux, A., & Simonofski, A. (2023). Modelling e-participation implementation: A network-based approach for online and offline participation. *Joint Proceedings of Ongoing Research, Practitioners, Posters, Workshops, and Projects at EGOV-CeDEM-ePart 2023*, *3449*, [1-12] Paper no. 6.

Bono Rossello, N., Simonofski, A., Clarinval, A., & Castiaux, A. (2024). A typology for AI-enhanced online ideation: Application to digital participation platforms. In T. X. Bui (Ed.), *Proceedings of the 57th Hawaii International Conference on System Sciences (HICSS-57)* (p. [1-10]). University of Hawaii at Manoa.

Borchers, M., Tavanapour, N., & Bittner, E. (2023). Exploring AI supported citizen argumentation on urban participation platforms. In T. X. Bui (Ed.), *56th Annual Hawaii International Conference on System Sciences (HICSS 2023)* (p. [1-10]). University of Hawaii.

Chanson, M., Bogner, A., Bilgeri, D., Fleisch, E., & Wortmann, F. (2019). Blockchain for the IoT: Privacy-Preserving Protection of Sensor Data. *Journal of the Association for Information Systems*, 1272–1307. https://doi.org/10.17705/1jais.00567

Chantillon, M., Crompvoets, J., & Peristeras, V. (2017). The Governance Landscape of Geospatial E-Services—The Belgian Case. *ISPRS International Journal of Geo-Information*, *6*(9), 282. https://doi.org/10.3390/ijgi6090282

Chiang, C.-W., Lu, Z., Li, Z., & Yin, M. (2023). Are Two Heads Better Than One in AI-Assisted Decision Making? Comparing the Behavior and Performance of Groups and Individuals in Human-AI Collaborative Recidivism Risk Assessment. *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, 1–18. https://doi.org/10.1145/3544548.3581015

Chun, S. A., Luna-Reyes, L. F., & Sandoval-Almazán, R. (2012). Collaborative e-government. In *Transforming Government: People, Process and Policy* (Vol. 6, Issue 1, pp. 5–12). https://doi.org/10.1108/17506161211214868

Clarinval, A., Albert, J., Schelings, C., Elsen, C., Dumas, B., & Castiaux, A. (2023). Idea Browsing on Digital Participation Platforms: A Mixed-Methods Requirements Study. In S. Nurcan, A. L. Opdahl, H. Mouratidis, & A. Tsohou (Eds.), *Research Challenges in Information Science: Information Science and the Connected World* (pp. 35–50). Springer Nature Switzerland.

Coenen, J., Houben, M., & Moere, A. V. (2019). Citizen Dialogue Kit: Public Polling and Data Visualization Displays for Bottom-Up Citizen Participation. In *Companion Publication of the 2019 on Designing Interactive Systems Conference 2019 Companion* (pp. 9–12). Association for Computing Machinery. https://doi.org/10.1145/3301019.3325160

Cortes-Cediel, M. E., Cantador, I., & Rodríguez Bolívar, M. P. (2020). Technological and Human Development of Smart Cities: An Empirical Characterization of EUROCITIES Case Studies. In *Proceedings of the 53rd Hawaii International Conference on System Science (HICSS-53)* (pp. 2293–2302). University of Hawai'i at Manoa. https://doi.org/10.24251/HICSS.2020.280

Davies, J., Arana-Catania, M., Procter, R., van Lier, F.-A., & He, Y. (2021). Evaluating the application of NLP tools in mainstream participatory budgeting processes in Scotland. *14th International Conference on Theory and Practice of Electronic Governance*, 362–366. https://doi.org/10.1145/3494193.3494242

Duberry, J. (2022). *Artificial Intelligence and Democracy: Risks and Promises of AI-Mediated Citizen–Government Relations*. Edward Elgar Publishing. https://doi.org/10.4337/9781788977319

Egger, R., & Yu, J. (2022). A Topic Modeling Comparison Between LDA, NMF, Top2Vec, and BERTopic to Demystify Twitter Posts. *Frontiers in Sociology*, *7*, 886498. https://doi.org/10.3389/fsoc.2022.886498

Ehsan, U., Liao, Q. V., Muller, M., Riedl, M. O., & Weisz, J. D. (2021). Expanding Explainability: Towards Social Transparency in AI systems. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–19. https://doi.org/10.1145/3411764.3445188

Feine, J., Morana, S., & Maedche, A. (2020). *Designing Interactive Chatbot Development Systems*.

Følstad, A., Larsen, A. G., & Bjerkreim-Hanssen, N. (2023). The human likeness of government chatbots–An empirical study from Norwegian municipalities. *International Conference on Electronic Government*, 111–127.

Gascó, M. (2017). Living labs: Implementing open innovation in the public sector. *Government Information Quarterly*, *34*(1), 90–98. https://doi.org/10.1016/j.giq.2016.09.003

Gebbing, P. (2022). Creative Virtual Collaboration Through the Lens of Design Science Research. *Creativity and Cognition*, 688–693. https://doi.org/10.1145/3527927.3533736

Goodchild, M. F. (2007). Citizens as sensors: The world of volunteered geography. *GeoJournal*, *69*(4), 211–221. https://doi.org/10.1007/s10708-007-9111-y

Gregor, S., Kruse, L., University of Liechtentsein, Liechtentsein, Seidel, S., & University of Liechtentsein, Liechtentsein. (2020). Research Perspectives: The Anatomy of a Design Principle. *Journal of the Association for Information Systems*, *21*, 1622–1652. https://doi.org/10.17705/1jais.00649

Gupta, P., & Woolley, A. W. (2021). Articulating the Role of Artificial Intelligence in Collective Intelligence: A Transactive Systems Framework. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *65*(1), 670–674. https://doi.org/10.1177/1071181321651354c

Hasan, M., Maarop, N., Naswir, R. Y., Samy, G. N., Magalingam, P., & Yaácob, S. (2018). *A PROPOSED CONCEPTUAL SUCCESS MODEL OF CITIZEN-CENTRIC DIGITAL GOVERNMENT IN MALAYSIA*.

Haße, H., Van Der Valk, H., Möller, F., & Otto, B. (2022). Design Principles for Shared Digital Twins in Distributed Systems. *Business & Information Systems Engineering*, *64*(6), 751–772. https://doi.org/10.1007/s12599-022-00751-1

Havrda, M. (2020). Artificial Intelligence's Role in Community Engagement within the Democratic Process. *International Journal of Community Well-Being*, *3*(4), 437–441. https://doi.org/10.1007/s42413-020-00100-8

Herm, L.-V., Steinbach, T., Wanner, J., & Janiesch, C. (2022). A nascent design theory for explainable intelligent systems. *Electronic Markets*, *32*(4), 2185–2205. https://doi.org/10.1007/s12525-022-00606-3

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *Management Information Systems Quarterly*, *28*, 75-.

Hoekstra, M., & van Veenstra, A. F. (n.d.). *A Typology for Applications of Public Sector AI*.

Holgersson, J., & Karlsson, F. (2014). Public e-service development: Understanding citizens' conditions for participation. In *Government Information Quarterly* (Vol. 31, Issue 3, pp. 396–410). https://doi.org/10.1016/j.giq.2014.02.006

Iivari, J., Rotvit Perlt Hansen, M., & Haj-Bolouri, A. (2021). A proposal for minimum reusability evaluation of design principles. *European Journal of Information Systems*, *30*(3), 286–303. https://doi.org/10.1080/0960085X.2020.1793697

Irvin, R. A., & Stansbury, J. (2004). Citizen Participation in Decision Making: Is It Worth the Effort? *Public Administration Review*, *64*(1), 55–65. https://doi.org/10.1111/j.1540-6210.2004.00346.x

Janowski, T. (2015). Digital government evolution: From transformation to contextualization. In *Government Information Quarterly* (Vol. 32, Issue 3, pp. 221–236). https://doi.org/10.1016/j.giq.2015.07.001

Johnson, P. C., Laurell, C., Ots, M., & Sandström, C. (2022). Digital innovation and the effects of artificial intelligence on firms' research and development – Automation or augmentation, exploration or exploitation? *Technological Forecasting and Social Change*, *179*, 121636. https://doi.org/10.1016/j.techfore.2022.121636

Jones, D., & Gregor, S. (2007). The Anatomy of a Design Theory. *Journal of the Association for Information Systems*, *8*(5), 312–335. https://doi.org/10.17705/1jais.00129

Khan, A., & Krishnan, S. (2021). Citizen engagement in co-creation of e-government services: A process theory view from a meta-synthesis approach. *Internet Research*, *31*(4), 1318–1375. https://doi.org/10.1108/INTR-03-2020-0116

Klijn, E. H., & Koppenjan, J. (2015). *Governance Networks in the Public Sector* (0 ed.). Routledge. https://doi.org/10.4324/9781315887098

Kluge, S. (2000). Empirically grounded construction of types and typologies in qualitative social research. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, *1*(1).

Koch, G., Hutter, K., Decarli, P., Hilgers, D., & Fuller, J. (2013). *Identifying Participants' Roles in Open Government Platforms and Its Impact on Community Growth*. 1900–1910.

Koppenhagen, N., Gaß, O., & Müller, B. (2012). *Design science research in action-anatomy of success critical activities for rigor and relevance*. 20th European Conference on Information Systems, Barcelona: Spain.

Lago, N., Durieux, M., Scoubeau, C., Elsen, C., & Schelings, C. (2019). *Citizen Participation through Digital Platforms: The Challenging Question of Data Processing for Cities*.

Laud, G., Bove, L., Ranaweera, C., Leo, W. W. C., Sweeney, J., & Smith, S. (2019). Value co-destruction: A typology of resource misintegration manifestations. *Journal of Services Marketing*, *33*(7), 866–889.

Leclercq, T., Hammedi, W., & Poncin, I. (2016). Ten years of value cocreation: An integrative review. *Recherche et Applications En Marketing (English Edition)*, *31*(3), 26–60. https://doi.org/10.1177/2051570716650172

Lee, G., & Kwak, Y. H. (2012). An Open Government Maturity Model for social media-based public engagement. In *Government Information Quarterly* (Vol. 29, Issue 4, pp. 492–503). https://doi.org/DOI%252010.1016/j.giq.2012.06.001

Lember, V., Brandsen, T., & Tõnurist, P. (2019). The potential impacts of digital technologies on co-production and co-creation. In *Public Management Review* (Vol. 21, Issue 11, pp. 1665–1686). https://doi.org/10.1080/14719037.2019.1619807

Letki, N., & Steen, T. (2021). Social-Psychological Context Moderates Incentives to Co-produce: Evidence from a Large-Scale Survey Experiment on Park Upkeep in an Urban Setting. *Public Administration Review*, *81*(5), 935–950. https://doi.org/10.1111/puar.13340

Linders, D. (2011). *We-Government: An anatomy of citizen coproduction in the information age*. 167–176. http://doi.acm.org/10.1145/2037556.2037581

Lindgren, I. (2014). Stakeholder Involvement in Public e- Service Development – Broadening the Scope of User Involvement. *Electronic Government and Electronic Participation: Joint Proceedings of Ongoing Research and Projects of IFIP WG 8.5 EGOV and ePart 2014*.

Loeffler, E., & Bovaird, T. (2018). *Assessing the Effect of Co-Production on Outcomes, Service Quality and Efficiency* (pp. 269–280). https://doi.org/10.4324/9781315204956-43

Macintosh, A., Coleman, S., & Schneeberger, A. (2009). eParticipation: The Research Gaps. In A. Macintosh & E. Tambouris (Eds.), *Electronic Participation* (Vol. 5694, pp. 1–11). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-03781-8_1

Matheus, R., Janssen, M., & Janowski, T. (2021). Design principles for creating digital transparency in government. In *Government Information Quarterly* (Vol. 38, Issue 1, p. 101550). https://doi.org/10.1016/j.giq.2020.101550

Molina, M. D., & Sundar, S. S. (2022). When AI moderates online content: Effects of human collaboration and interactive transparency on user trust. *Journal of Computer-Mediated Communication*, *27*(4), zmac010. https://doi.org/10.1093/jcmc/zmac010

Möller, F., Guggenberger, T. M., & Otto, B. (2020). Towards a Method for Design Principle Development in Information Systems. In *Designing for Digital Transformation. Co-Creating Services with Citizens and Industry* (Vol. 12388, pp. 208–220).

Möller, F., Schoormann, T., Strobel, G., & Hansen, M. R. P. (2022). Unveiling the Cloak: Kernel Theory Use in Design Science Research. *Proc. Int. Conf. Inf. Syst.*, 1–17.

Nambisan, S., & Nambisan, P. (2013). Engaging citizens in co-creation in public services. *IBM Center for Business Development*, *8*, 48–49.

No, W., Mook, L., & Schugurensky, D. (2017). Ideation in an online participatory platform: Towards a conceptual framework1. *Information Polity*, *22*(2–3), 101–116. https://doi.org/10.3233/IP-170417

Pan, J. (2022). Research on privacy risk identification in government data sharing. *Proceedings of the 6th International Seminar on Education, Management and Social Sciences (ISEMSS 2022)*, 3255–3260. https://doi.org/10.2991/978-2-494069-31-2_383

Pariser, E. (2011). *The filter bubble: What the Internet is hiding from you*. penguin UK.

Pöhler, L., Schuir, J., Meier, P., & Teuteberg, F. (2021). *Let's Get Immersive: How Virtual Reality Can Encourage User Engagement in Process Modeling*.

Porwol, L., Ojo, A., & Breslin, J. G. (2016). An ontology for next generation e-Participation initiatives. In *Government Information Quarterly* (000385057300021; Vol. 33, Issue 3, pp. 583–594). https://doi.org/10.1016/j.giq.2016.01.007

Rodriguez Müller, A. P., Lerusse, A., Steen, T., & Van De Walle, S. (2021). Understanding channel choice in users' reporting behavior: Evidence from a smart mobility case. *Government Information Quarterly*, *38*(1), 101540. https://doi.org/10.1016/j.giq.2020.101540

Romberg, J., & Escher, T. (2022). Automated Topic Categorisation of Citizens' Contributions: Reducing Manual Labelling Efforts Through Active Learning. In *Electronic Government* (Vol. 13391, pp. 369–385). Springer International Publishing.

Sætra, H. S. (2021). A Typology of AI Applications in Politics. In *Artificial Intelligence and Its Contexts* (pp. 27–43). Springer International Publishing. https://doi.org/10.1007/978-3-030-88972-2_3

Sarker, I. H. (2022). AI-Based Modeling: Techniques, Applications and Research Issues Towards Automation, Intelligent and Smart Systems. *SN Computer Science*, *3*(2), 158. https://doi.org/10.1007/s42979-022-01043-x

Savaget, P., Chiarini, T., & Evans, S. (2019). Empowering political participation through artificial intelligence. *Science and Public Policy*, *46*(3), 369–380. https://doi.org/10.1093/scipol/scy064

Schermann, M., Andreas, G., Krcmar, H., & Pohl, K. (2009). Justifying design decisions with theory-based design principles. *Conference: 17th European Conference on Information Systems, ECIS 2009, Verona, Italy, 2009*.

Scott, W. R., & Davis, G. F. (2015). *Organizations and organizing: Rational, natural and open systems perspectives*. Routledge.

Shin, B. (2023). Residents' voices on proposals: Analysing a participatory budgeting project in Seoul using topic modelling. In N. Edelmann, L. Danneels, A.-S. Novak, P. Panagiotopoulos, & I. Susha (Eds.), *Proceedings of the 15th IFIP WG 8.5 International Conference (ePart 2023)* (pp. 50–64). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-41617-0_4

Shin, B., Floch, J., Rask, M., Bæck, P., Edgar, C., Berditchevskaia, A., Mesure, P., & Branlat, M. (2024). A systematic analysis of digital tools for citizen participation. *Government Information Quarterly*, *41*(3), 101954. https://doi.org/10.1016/j.giq.2024.101954

Shin, B., & Rask, M. (2021). Assessment of Online Deliberative Quality: New Indicators Using Network Analysis and Time-Series Analysis. *Sustainability*, *13*(3), 1187. https://doi.org/10.3390/su13031187

Siangliulue, P., Chan, J., Dow, S. P., & Gajos, K. Z. (2016). IdeaHound: Improving Large-scale Collaborative Ideation with Crowd-Powered Real-time Semantic Modeling. *Proceedings of the 29th Annual Symposium on User Interface Software and Technology*, 609–624. https://doi.org/10.1145/2984511.2984578

Sieber, R. E., & Johnson, P. A. (2015). Civic open data at a crossroads: Dominant models and current challenges. In *Government Information Quarterly* (Vol. 32, Issue 3, pp. 308–315). ScienceDirect. https://doi.org/10.1016/j.giq.2015.05.003

Simonofski, A., Fink, J., & Burnay, C. (2021). Supporting policy-making with social media and e-participation platforms data: A policy analytics framework. In *Government Information Quarterly* (Vol. 38, Issue 3, p. 101590). https://doi.org/10.1016/j.giq.2021.101590

Simonofski, A., Johannessen, M. R., & Stendal, K. (2024). Extended reality for citizen participation: A conceptual framework, systematic review and research agenda. *Sustainable Cities and Society*, *113*, 105692. https://doi.org/10.1016/j.scs.2024.105692

Simonofski, A., Snoeck, M., & Vanderose, B. (2019). Co-creating e-Government Services: An Empirical Analysis of Participation Methods in Belgium. In *Setting Foundations for the Creation of Public Value in Smart Cities* (Vol. 35, pp. 225–245). Springer International Publishing. https://doi.org/10.1007/978-3-319-98953-2_9

Stapley, E., O'Keeffe, S., & Midgley, N. (2022). Developing Typologies in Qualitative Research: The Use of Ideal-type Analysis. *International Journal of Qualitative Methods*, *21*, 160940692211006. https://doi.org/10.1177/16094069221100633

Steen, T. (2021). Citizens' Motivations for Co-production: Willingness, Ability and Opportunity at Play. In E. Loeffler & T. Bovaird (Eds.), *The Palgrave Handbook of Co-Production of Public Services and Outcomes* (pp. 507–525). Springer International Publishing. https://doi.org/10.1007/978-3-030-53705-0_26

Steen, T., Brandsen, T., & Verschuere, B. (2018). *The Dark Side of Co-Creation and Co-Production: Seven Evils*. https://doi.org/10.4324/9781315204956-45

Strauss, A. L., & Corbin, J. M. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Sage Publications.

Tamilmani, K., Rana, N. P., & Dwivedi, Y. K. (2021). Consumer Acceptance and Use of Information Technology: A Meta-Analytic Evaluation of UTAUT2. *Information Systems Frontiers*, *23*(4), 987–1005. https://doi.org/10.1007/s10796-020-10007-6

Toots, M. (2019). Why E-participation systems fail: The case of Estonia's Osale.ee. In *Government Information Quarterly* (Vol. 36, Issue 3, pp. 546–559). https://doi.org/10.1016/j.giq.2019.02.002

Vaishnavi, V., & Kuechler, W. (2007). Design Science Research Methods and Patterns: Innovating Information and Communication Technology. In *Design Science Research Methods and Patterns: Innovating Information and Communication Technology* (p. 226).

Van Eijk, C., Steen, T., & Torenvlied, R. (2019). Public Professionals' Engagement in Coproduction: The Impact of the Work Environment on Elderly Care Managers' Perceptions on Collaboration With Client Councils. *The American Review of Public Administration*, *49*(6), 733–748. https://doi.org/10.1177/0275074019840759

van Noordt, C., & Misuraca, G. (2022). Exploratory insights on artificial intelligence for government in Europe. In *Social Science Computer Review* (Vol. 40, Issue 2, pp. 426–444). https://doi.org/10.1177/0894439320980449

Venable, J. (2006). The role of theory and theorising in design science research. *Proc. Int. Conf. Des. Sci. Res. Inf. Syst. Technol.*, 1–18.

Voets, J., Van Dooren, W., & De Rynck, F. (2008). A Framework for Assessing the Performance of Policy Networks. *Public Management Review*, *10*(6), 773–790. https://doi.org/10.1080/14719030802423129

Vom Brocke, J., Simons, A., Riemer, K., Niehaves, B., Plattfaut, R., & Cleven, A. (2015). Standing on the Shoulders of Giants: Challenges and Recommendations of Literature Search in Information Systems Research. *Communications of the Association for Information Systems*, *37*. https://doi.org/10.17705/1CAIS.03709

Wache, H., Möller, F., Schoormann, T., Strobel, G., & Petrik, D. (2022). *Exploring the abstraction levels of design principles: The case of chatbots*. 17th International Conference on Wirtschaftsinformatik (WI), Nürnberg: Germany.

Wahl, J., Hutter, K., & Füller, J. (2022). How AI-supported searches through other perspectives affect ideation outcomes. *International Journal of Innovation Management*, *26*(09), 2240028. https://doi.org/10.1142/S136391962240028X

Walls, J. G., Widmeyer, G. R., & El Sawy, O. A. (1992). Building an Information System Design Theory for Vigilant EIS. *Information Systems Research*, *3*(1), 36–59. https://doi.org/10.1287/isre.3.1.36

Wang, X., & Van Wart, M. (2007). When Public Participation in Administration Leads to Trust: An Empirical Assessment of Managers' Perceptions. *Public Administration Review*, *67*(2), 265–278. https://doi.org/10.1111/j.1540-6210.2007.00712.x

Wasserman, S., & Faust, K. (n.d.). *Social Network Analysis: Methods and Applications*.

Wijnhoven, F., Ehrenhard, M., & Kuhn, J. (2015). Open government objectives and participation motivations. In *Government Information Quarterly* (Vol. 32, Issue 1, pp. 30–42). https://doi.org/10.1016/j.giq.2014.10.002