A Framework for Categorising and Evaluating Tools for e-Democracy

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Abstract: The design of tools and interfaces for e-democracy systems takes place in a highly multidisciplinary context. However, the inter-contextual understanding of democracy is still immature. This article presents a framework suitable for evaluating tools for e-democracy. The framework has been developed based on earlier theories and frameworks and then further evaluated against two test cases: Twitter and BottenAda. The evaluation model builds on the inclusion of different views of e-democracy, not seeing them as conflicting per se but rather making it possible for e-democracy tool users and developers to understand the varying degree of support a tool can display for several aspects of democracy. The model also provides a visualization of complex theories and can thus contribute to a more informed discussion on what types of democratic values are being supported in a particular e-democracy tool.

Keywords: e-democracy, democracy index, e-participation, e-service, open government, evaluation model

1. Introduction

The concept of e-democracy is complicated and connotes a variety of subjects, such as e-participation and open government. E-participation in itself represents a fragmented field of definitions, theories, and methods. Open government assumes many concepts that are inherently problematic in some respects, not least concerning the issues of representativeness where the relationships between the citizens and the state are far from uncomplicated. All this affects the variety of tools designed for e-democratic and e-governance purposes, and to navigate in this plethora it would be meaningful to have some kind of evaluation model to better understand the usability and properties of the available tools and underlying models. In this article, we propose how such a model can be designed. While doing this, we will nevertheless try to avoid the more fundamental discussion about the inner nature and the various general aspects of democracy, but rather try to elaborate on a kind of unifying and fairly open framework that we believe can be suitable for evaluating tools for e-democracy. Our underlying idea is to take an inclusive perspective aiming at being able to take very different views of e-democracy into account while not seeing them as conflicting per se. The idea is to make it possible for tool users and developers to understand the varying characteristics and degrees of support that are possible.

We exemplify how this can be carried out using a selected subset of properties being important for e-democracy in a very general sense. We also try to provide a visualization of different (even complex) theories and thus contribute to a more informed discussion of what types of democratic values are being supported in different e-democracy tools. However, the latter fact is not a limitation since our evaluation model can be applied to various subsets of democracy aspects in different contexts. This could, for example, contain only a few dimensions such as information quality and efficient distribution, or contain a significantly larger superset of attributes, such as flexibility in participation, reasonable voting possibilities, explanation and enlightenment, representativeness, agenda control, equality, inclusion, Internet access, anonymity, protection of privacy, transaction security, fraud detection mechanisms, depending on the circumstances and of the purposes of the tools investigated. There are thus no particular limitations to the model, neither regarding contexts nor component domains. The model can furthermore be used for handling hierarchies of attributes and can therefore be quite useful also in complex contexts.

The main contribution is a comparatively simple model used as the basis for a method for conceptualizing components supporting e-democracy as well as for the evaluation of how these dimensions can visually position different components of e-democracy. We also suggest how to use the model for evaluating tools to support participation and how tools for supporting e-democracy can then be measured in terms of the degree of support for the various components. This enables users to evaluate and hence select tools to support participation.

2. Research Overview

It is somewhat unclear what a fully shared understanding of democratic participation in the information and communication technology (ICT) landscape would mean since it involves so many different research perspectives and practices. We refrain from scrutinizing the manifold of ideas that have been flourishing for many hundreds of years in the various sub-fields on structural, formal, and pragmatic aspects vs. ideological aspects, but a few comments are pertinent to understanding our aims with this article. Much of the e-democracy literature emphasize democratic rights and understanding through transparency. This is extensively discussed in, e.g., (Ekenberg et al., 2017). Also, the earlier stages of policy design and design theory are of critical value in the processes, and some, such as Bellamy (2000), label this emphasis as the *consumer model* since it focuses on citizens as consumers of public services and their legal rights against the state. Others, such as Dahlberg (2011), argue that this is where most of the development of e-democracy takes place, i.e. in projects providing citizens with better services, increased accessibility, and information transparency. Or simply to improve government accountability and "customer service" through flexible information systems and more informed decision making. Especially in the areas of e-government and open government, transparency is emphasized and concepts such as interoperability and open data have to a large extent been dominating the scene (Hansson, 2015).

Another strongly interlinked part of e-democracy deals with e-participatory models. Many studies have discussed the effects of open government and e-participation, such as (Al-Jamal and Abu-Shanab, 2016) and some interesting spin-offs thereof, notably (Komendatova et al., 2018). There are several overviews of such models with a somewhat fragmented plethora of definitions, theories, and methods, see, e.g., (Susha and Grönlund, 2012). A more recent survey is provided in (Naranjo-Zolotov, Olivera, and Casteleyn, 2018). Further, (Porwol, Oja, and Breslin, 2018) provides state-of-the-art coverage of e-participation and discusses a set of requirements for Social Software Infrastructure (SSI) as well as an integrated model for e-participation. There are, of course, several issues involved here as well. For instance, (Hansson, Belkacem, and Ekenberg, 2014) point out some shortcomings in the underlying concepts of democracy, in particular with issues concerning representativeness.

When it comes to tool support, most commonly used tools for e-participation, such as social platforms, music, photo, video sharing tools, and microblogs, are developed by the private sector. But there are also some examples of public sector projects aiming at making the sector more transparent, such as OpenCongress (Lee, 2014). There are, further, some more innovative projects, exemplified by Diplopedia (Cozzani, 2015), the US State Department's wiki for Foreign Affairs information, Intellipedia, a joint information source for US Intelligence Agencies and Departments (Ben Eli and Hutchins, 2010), GCpedia, the Government of Canada's wiki (Fyfe and Crookall, 2010), and MyUniversity (Mobini and Hansson, 2014) for educational settings. Other common categories include various wikis and community portals for collaboratively sharing information about local places. Here, the issue of validation is crucial and there is a range of possible improvements, not least when it comes to actual e-voting processes and tools such as data security, privacy, and counting auditability. There are also some platforms, notably Votem[1] and Votewatcher[2], that are using blockchain-based encryption.

How should these models and tools be categorised and analysed with respect to their intended use in a more general democracy setting and as participation-enabling instruments? The idea in this paper is to introduce a more elaborated index for this categorisation purpose. An index that can be used for visualising the various features included in the models and tools. Commonly used democracy indices, where Coppedge et al. (2017) provide an overview of different indices and their properties, are very similar from a mathematical perspective and many of them use variants of weighted averages based on questions or criteria sets, such as, e.g., the Economist's Democracy Index (2019) or Freedom House[3]. Skaaning (2018) provides another overview of the current state of democracy indices with similar conclusions. The current indices seem to be unnecessarily simplified and can be improved considerably from an elicitation perspective to increase their granulation and adequacy. This is similar to the situation in the area of multi-criteria decision analysis, where (Riabacke, Danielson, and Ekenberg, 2012) provides a thorough overview of various issues involved, including some trade-off discussions. One crucial issue in practice is how to realistically elicit criteria weights (and also values) from

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[1] https://www.votem.com.

[2] http://votewatcher.com.

[3] https://freedomhouse.org/report/freedom-world/freedom-world-2019/democracy-in-retreat.

users in such a way that they can provide information they understand the meaning of, since the elicitation of exact numbers demands an exactness which does rarely exist. We have therefore argued that ordinal or other imprecise importance (and preference) information could successfully be used for determining criteria weights (and values of entities). Surrogate weights (and values), which are derived from ordinal and cardinal importance (and value) information, could be very useful in the elicitation process (cf., e.g., Danielson and Ekenberg, 2016ab). In surrogate-number methods, the decision-maker provides information on the rank order of the criteria, i.e. supplies ordinal information on relative importance. Thereafter, the information is converted into numerical weights consistent with the extracted ordinal information. We will use the latter technique when constructing an index underlying the visualisation model discussed below. To better understand the feature of this index, we will first briefly discuss four aspects of democracy that will be used as underlying components in the index to illustrate the model. There are many more components that might and possibly should be included, but the inclusion of other aspects of relevance in a particular context can be analogously handled.

3. Aspects of Democracy

There are several important aspects of democracy and many of them concern societal decision-making processes. Central to those processes are transparency and individual autonomy, i.e. that there is a clear understanding of the pros and contras involved in the various issues on the agendas as well as the opportunity to freely discuss them and influence the results. Another important aspect is public participation in the sub-processes, such as the agenda-formation, consensus-building, discussions, and analyses as well as the actual voting procedures and the regulations around them. A broad pluralism and a diversity of conflicting perspectives on different levels seem furthermore to be of importance in the different phases during the process. In the following, we will use these democracy aspects to illustrate our model. More precisely, we will use four aspects of democracy to serve as positioning criteria in order to demonstrate the tool index that makes up the core of the paper. We could have selected a larger or a different set of criteria, but this would not have added anything to the explanative strength of the presentation. A user of this indexing framework should select his or her own set of criteria to mirror the purpose and perspective applied. Since the main focus of this article is how to utilise the index and not to scrutinize the concept of democracy itself, four criteria seem to suffice to demonstrate the utility of the index approach without obfuscating the results with too much calculation details.

3.1 A Sample of Relevant Aspects

Transparency is an important aspect of democracy in general. Provided that there is governmental transparency, gathering information through autonomous actors makes information more easily available in the context of e-democracy. Another component, that can be facilitated by e-democracy tools, is citizen-to-citizen and citizen-to-government dialogues, enabling a bottom-up approach to information production and sharing where the public may participate.

Autonomy for the individual and the right to associate as well as to disassociate with communities is often considered as a basic democratic right (Bader, 2012). Micro-democratic processes in autonomous networks, what Dahlberg (2011) calls an autonomous-Marxist discourse, is also seen as a production principle where reciprocal relationships between equals replace a hierarchical workflow. This "cyber-democratic" model has sometimes been seen as one of the most radical changes to traditional democratic institutions (Päivärinta and Sæbø, 2006). Citizen dialogue is considered central, such as in SeeClickFix and FixMyStreet (Cantijoch, Galandini and Gibson, 2015; Szkuta, Pizzicannella, and Osimo, 2014) for identifying neighbourhood issues and in Ushahidi (Marsden, 2013) regarding how to collect eyewitness reports of violence.

The focus here is usually on improving the quality of citizens' participation and involvement by using tools for collective decisions and/or information production to create and refine information and shared understanding: agenda-setting, arguing, deliberation, education, opinion-formation, and negotiating. Support tools for deliberative processes therefore also aim at structuring the decision situation and provide information regarding the alternatives and criteria involved (Danielson, Ekenberg, and Larsson, 2019). Deliberation can also be seen as a culture, a behaviour that needs to be established. This is, for example, the ambition of Regulationroom.org, an online experimental e-participation platform that aims to open up rulemaking processes in legislation by inviting the public to review new regulations (Farina et al., 2013).

An important feature of democracy is the tolerance and the existence of a plurality of values and identities. In an e-democracy context, this means the formation of a diversity of public spheres that develop their discourses

in enclosed counter-publics (Dahlberg, 2011). This position focuses on how different interest groups are more actively involved in the formation of consensus. Components supporting pluralism should acknowledge diversity, inequality, and conflicts, and also support the establishment of counter-cultures, collective actions, community building, campaigning, contesting, organizing, and protesting.

3.2 A Map of Different Aspects of Democracy

We will now use the abovementioned sample positions and Päivärinta and Sæbø's model for e-democracy (2006) to design a map illustrating how the different positions above are related to each other. The map uses the four positions shown in Figure 1.

Transparency: Components that support the sharing of data between agencies, government to citizens, and citizens to citizens, where the aim is better services, efficiency, and innovation: aggregating, competing, informing, petitioning, transacting, transmitting, voting, and controlling.

Autonomy: Components that support forms for open-source cultures where participants typically collaborate motivated by peer recognition or other micro-rewards: networking, collaborating, distributing, and sharing.

Consensus: Components that support forms for collective decisions and information production to develop information and shared understanding: agenda-setting, arguing, deliberating, informing and educating, meeting, opinion-forming, reflecting, trade-off analysis, and negotiating.

Pluralism: Components that acknowledge and enable diversity, inequality, and conflicts. Support for establishing counter-cultures and collective actions: associating, campaigning, contesting, forming groups, community building, organizing, mediating, and protesting.

Organizing, community building, and group formation are placed close to pluralism since they are about organizing interest communities and thus creating the conditions for organizing around a diversity of perspectives and interests. Tools for networking and collaborating are placed in the autonomy corner as these tools focus on creating conditions for the individual to act autonomously and to have direct contact with other autonomous actors in different networks.

These positions are relative and oppose each other in the map for the purpose of making the model possible to visualize. If we place our four different aspects of democracy on a map of different foci of democracy, we obtain a map that can be helpful in discussing and identifying which kinds of democratic aspects that different types of e-democracy projects and components can support. Note that these particular four criteria and their roles within the paper are to demonstrate a general indexing method that should be adopted by the method users by incorporating appropriate criteria for the intended purpose. Below, we demonstrate how such a mapping can also lead to a categorisation of the tools by an index as a complement to and operationalization of the map itself.
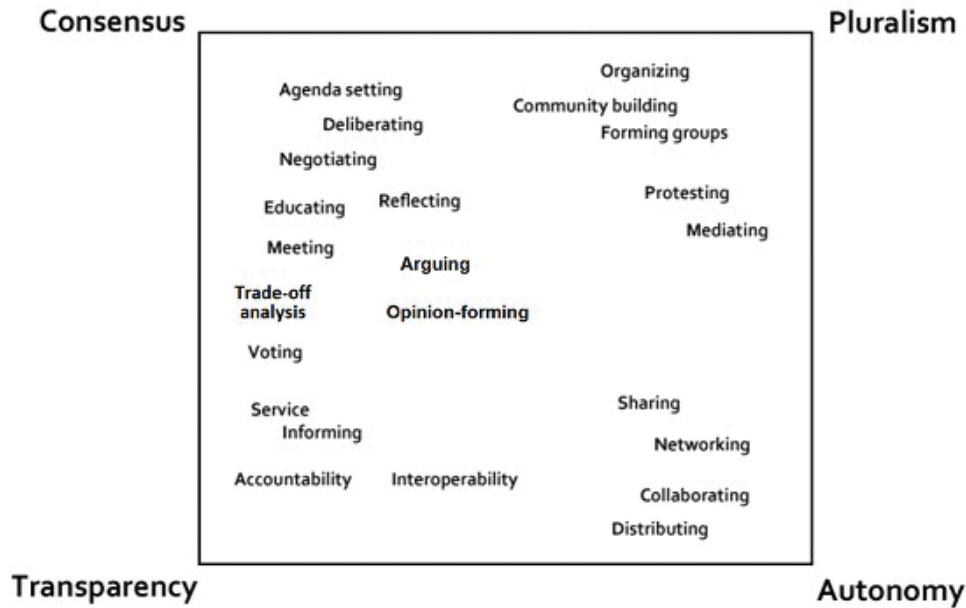
Figure 1: Visual positioning of components needed to support the four dimensions of democracy

4. Methodological Considerations

In general, elicitation efforts can be grouped into a) methods handling the outcome of an elicitation by precise numbers as representatives of the information elicited and b) methods instead handling the outcome by using less precise (interval-valued) information. But there are also other approaches, less reliant on high information precision on the part of the decision-maker while still aiming at non-interval representations.

Today's commonly used democracy indices are very similar from a mathematical perspective. To gain an overview, we surveyed the usage of the terms *democracy/dictatorship index*, *index of democracy*, *list of freedom index*, and *democracy ranking*. In the indices we found, most use a weighted average based on questions or criteria sets, such as, e.g., in the Economist's Democracy Index (2019) on electoral process and pluralism, civil liberties, the functioning of government, political participation and political culture, or thinner ones such as Freedom House. For instance, (Pirannejad, Janssen, and Rezaei, 2019) provides an overview of indices and suggest a weighted average model for e-participation. Most of the indices assess criteria weights using exact numbers. These methods range from relatively simple ones, such as direct rating and point allocation methods, to somewhat more advanced procedures. Generally, in these approaches, precise numerical values are assigned to criteria and performance values to represent the information extracted. There exist various weighting methods that utilise questioning procedures for elicitation, but the requirement for numeric precision in the input information is in any case problematic. This is because people's beliefs are not naturally represented as numerically precise terms, cf., e.g., (Danielson, Ekenberg, and Riabacke, 2009; Ekenberg et al., 2009).

Therefore, our suggestion tries to accommodate these considerations and suggests a ranking method that goes beyond the commonly used scales also for rankings and where we have quite conservatively extended a purely ordinal scale approach with the possibility to supply cardinal information as well. The discrimination formula that we used is validated by simulation studies similar to (Barton and Barrett, 1996; Ahn and Park, 2008; Butler, Jia, and Dyer, 1996) that have become de facto standards for comparing weight methods relevant for cardinal ordering methods. The details of the validations can be found in (Danielson and Ekenberg, 2016ab).

To obtain an adequate sample set of tools to investigate, we have scanned the literature for groupings and established categories where tools are used in the context of e-democracy services. For each of these categories, we aimed at identifying instances currently used in e-democracy. In this categorization, we were inspired by the early work performed during the eParticipation Network of Excellence project Demo-net[4] organized by the University of Koblenz. Wimmer (2007) identified three groups of tool categories that support democratic participation: *i*) core e-democracy tools, *ii*) ICT tools extensively used in e-democracy, and *iii*) basic ICT tools

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[4] https://participedia.net/organization/316

needed in e-democracy. This is a categorisation that still makes sense. Using these categories, the group of core e-democracy tools consists of artefacts especially designed and used for e-democracy services while the other groups, ICT tools extensively used in e-democracy and ICT tools needed in e-democracy, consist of generic interfaces that are designed as multi-purpose e-tools but are being used primarily as e-democracy services.

We have also elicited categories of tools from papers that discuss types of tools concerning particular projects or experiments and from the analyses of specialized fields within e-democracy research. Examples include (Sæbø, Rose, and Nyvang, 2009), who discuss the role of Social Networking Services (SNS) in e-participation, and (Danielson et al., 2010) who discuss decision analysis in e-participation as a social process and sketches a basic architecture for an ICT system to support such processes.

5. Core E-democracy Tools and Their Indexation

We will now turn to the index and apply it to a set of e-democracy tools emanating from our survey. The index is constructed from cardinal orderings of properties and the relevant criteria under consideration. The orderings are then transformed to surrogate numbers that are aggregated to form the index for the respective tool. Table 1 shows some categories of tools of interest that were used as well as brief descriptions of them.

Table 1: Characterisations of some e-democracy tools

Chat Rooms	Tools that support citizens in participating in real-time sessions. Can also be configured to support peer-to-peer communication.
Social Networks and Virtual Communities	Tools that facilitate communication, sharing resources, and other interaction activities such as gaming, between people who share a common interest.
Online Survey Tools	Tools that are web-based questionnaires where the public can submit responses online.
Deliberative Survey Tools and Deliberative Polls	Tools and polls that can be seen as a combination of traditional online survey tools but applied to focus groups where deliberation can take place.
E-consultation Tools	Tools that can be used by stakeholders to communicate and share information on specific issues, or get advice online, instead of meeting locally.
E-voting Tools	Systems that offer a secure environment for online voting.
E-petitions	Electronic lists where participants can sign up to support or protest against an issue.
Decision-Making Games	Games directed towards policy decision-making.
Internet-Based Decision Support	Computer-based systems used to retrieve data from the Internet and other sources and then to analyse this data.
Collaborative Environments	Systems that are used to support social interactions and collaboration.
Argument Visualization Tools	Software tools that use argument diagramming to analyse arguments.
Semantic Web Technologies	Technologies that support automatic extraction of semantic content.

5.1 Positioning Criteria

The following steps were undertaken to evaluate the degree of support of a tool relative to the four positioning criteria from Section 3:

Description and classification of a tool in terms of the categories in the survey.
- Measuring the tool in terms of an index defined in the next section and based on the four dimensions of e-democracy (transparency, autonomy, consensus, and pluralism) on a scale from where the tool displays no characteristics of any of the dimensions, to where the tool displays a maximum degree of the characteristics of all of the dimensions. In between, we could assert statements such as *The tool displays some characteristics of at least one of the dimensions* or *The tool displays characteristics of several of the dimensions*.

Note that tools can be measured under two interpretations, where the second one seems to be of more relevance in forming the index:
- The tool (or its managers/owners/manufacturers) itself claims that it supports a characteristic and no evidence contradicts this.

- It is evident, or at least very probable, that the users of a tool can use or uses it in a way that supports a characteristic.

5.2 Modelling and Evaluation

We will now show how an index, a weighted average over the (in our example) four dimensions, can be constructed. The method takes into account that there are usually large uncertainties and vagueness involved when characterizing tools concerning these kinds of criteria. A general way to create an index is to stipulate a set of criteria and evaluate a set of entities for them. A value function could preferably be the additive model $V(e) = \sum_{i=1}^{m} w_i v_i(e)$, where $V(e)$ is the overall value of an e-tool e that can be described by a set of values under multiple criteria. $v_i(e)$ is then the value of the e-tool under criterion i and w_i is the weight of this criterion. In a few cases, the weights are (quite artificially) considered to be equal. Except for these cases, the criteria weights are critical components describing the significance of each criterion in the context under consideration.

One key characteristic is that there is more than one perspective under which we view the set of entities to be evaluated, and for each perspective the evaluator must assign values to each e-tool on some value scale. An even more general situation can be modelled like the tree in Figure 2 where the criteria are also allowed to have sub-criteria, a feature that is more seldom used but can nevertheless improve the granularity of the entities under consideration. (Danielson, Ekenberg, and Larsson, 2019) discusses this in detail.
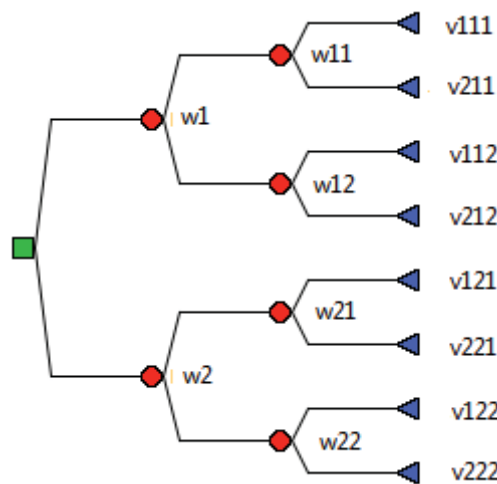

Figure 2: A multi-criteria tree with two criteria levels

To express the relative importance of the criteria, weights are restricted by a normalisation constraint $\sum_{j=1}^{m} w_j = 1$, where w_j denotes the weight of a criterion G_j and the weight of sub-criterion G_{jk} is denoted by w_{jk}. The value of e-tool E_i under sub-criterion G_{jk} is denoted by v_{ijk}. Then the weighted overall value of an e-tool E_i (from the example in Figure 2) can be calculated by $\sum_{j=1}^{2} w_j \sum_{k=1}^{2} w_{jk} v_{jik}$.

As we have discussed above, a practical issue is how to realistically elicit information from users. Ordinal or other imprecise importance (and preference) information could, for instance, be used for determining criteria weights (and values of entities). Many authors suggest using surrogate weights which are derived from ordinal importance information (cf., Danielson and Ekenberg, 2016ab). In such methods, the decision-maker provides information on the rank order of the criteria, i.e. supplies ordinal or cardinal information on importance, and thereafter this information is converted into numerical weights consistent with the extracted information.

5.3 CAR Weights and Values

A straightforward and robust method for cardinal ranking is CAR, which extends the idea of surrogate weights as one of the main components. The idea is to obtain information about how much more or less important the criteria are compared to each other.

In the following, we use $>_i$ to denote the strength (cardinality) of the rankings between criteria and values respectively, where $>_0$ is the equal ranking operator '='. Assume that we have a user induced ordering of criteria

weights $w_1 >_{i_1} w_2 >_{i_2} \ldots >_{i_{n-1}} w_n$. Then we construct a new ordering, containing only the symbols = and >, by introducing auxiliary variables w_{ij} and substituting

$$
\begin{aligned}
&w_k >_0 w_{k+1} \text{ with } w_k = w_{k+1} \\
&w_k >_1 w_{k+1} \text{ with } w_k > w_{k+1} \\
&w_k >_2 w_{k+1} \text{ with } w_k > x_{k_1} > w_{k+1} \\
&\ldots \\
&w_k >_i w_{k+1} \text{ with } w_k > x_{k_1} > \cdots > x_{k_{i-1}} > w_{k+1}
\end{aligned}
\qquad (1)
$$

and analogously for the values. In this way, we obtain a computationally meaningful way of representing preference weight and value strengths.

To see how this works, consider the cardinality expressions as distance steps on an importance scale. The number of steps corresponds straightforwardly to the strength of the cardinal relations above such that $' >_i '$ means i steps. The statements are then converted into weights. This is explained in detail in (Danielson and Ekenberg, 2016b), where also the performance of a set of cardinal weights are compared to ordinal weights. In this paper, we use the SR (Sum-Reciprocal) weights of the aforementioned article. Then the cardinal ranking weights w_i^{CAR} are found by the weight formula

$$
w_i^{CAR} = \frac{1/p(i) + \frac{Q+1-p(i)}{Q}}{\sum_{j=1}^{N}\left(1/p(j) + \frac{Q+1-p(j)}{Q}\right)}.
$$

which are effortlessly calculated by, e.g., a spreadsheet program. The values (assessments) of the various e-democracy tools under each criterion are elicited in a way similar to the weights. For each criterion in turn, each tool is ranked relative to a base (zero) tool depending on how well it performs in the particular dimension under consideration. As an example, consider Transparency. In Figure 3, some tools (A-E) are compared to the zero tool (a base tool with almost no useful capabilities in the dimension considered).

Figure 3: Tools assessed under the Transparency criterion

The positions on the ranking ruler in Figure 3 are then converted into rankings on the >*i* format. Each tool is assigned a ranking symbol >*i* in which the integer *i* represents the number of steps the tool is away from the zero tool base. For example, Tool D is represented by >**2** under the criterion Transparency. This scoring is repeated for each of the criteria being measured, in this example four. Thus, we obtain four rankings, one along each of the criteria. For Tool D, this might have yielded Transparency: >**1**; Autonomy: >**1**; Consensus: >**3**; and Pluralism: >**1**. Only Transparency: >**2** is shown in the figure but the others would have been measured on similar scales for the other three perspectives. Tables 2 and 3 contain two real-world examples scored along the four dimensions in question.

Thereafter, a weighted overall value is calculated by multiplying the centroid of the weight simplex (i.e. the numbers best representing the weight relations, given by the CAR weight formula above) with the centroid of the e-tool value simplex (again, the numbers that best represents the value relations on rules such as in Figure 3). This can be pictured as obtaining a kind of "mean value" best representing the assessment of the e-tool. Thus, given a set of criteria in a (one-level) criteria hierarchy, $G_1, \ldots, G_n$ and a set of e-tools $a_1, \ldots, a_m$. A general value function U using additive value functions is then

$$
U(a_j) = \sum_{i=1}^{n} w_i^{CAR} v_{ij}^{CAR}
$$

where w_i^{CAR} is the weight representing the relative importance of attribute G_i, and $v_{ij}^{CAR}: a_j \rightarrow [0,1]$ is the increasing individual value function of a_j under criterion G_i obtained by the following procedure. As seen in the figure, for each criterion (i.e. characteristic), the integers k in the statements >k are interpreted as the values being k steps away from the zero tool. Each step is represented on the criterion's local value scale as $\alpha \cdot k$, where α is the scaling constant for the index. The scaling constant is determined by $\alpha = d/s$, where d is the desired target for the average of the indices and s is the expected average number of steps in the >k symbols used. Again, this is straightforwardly calculated in a spreadsheet.

Thus, the $U(a_j)$ expression is subject to the constraints in the polytopes of weights and values. This means that the feasible values are the ones in the extended polytopes defined by (1) above. Now, we define the weighted value

$$\bar{U}(a_j) = \sum_{i=1}^{n} \bar{w}_i \bar{v}_{ij}$$

as a general result value, where $\bar{w}_i$ is the centroid component of criteria weight w_i in the weight simplex and $\bar{v}_{ij}$ is the centroid component of the value of e-tool a_j under criterion G_i in the simplex of values. Since we only consider non-interval valued results, the centroid is the most representative single number of a polytope, thus reducing the operation to a sum of multiplied factors w_i and v_{ij}.

The criteria (in our example, the four characteristics transparency, autonomy, consensus, and pluralism, but more generally any set of e-democracy aspects) are then measured and weighted into an index reflecting the degree of fulfilment of the characteristics. The result will be a ranking of all the tools under consideration under each of the four criteria in relation to the zero tool. Thereafter, the criteria are ranked according to the method described above. The values and weights are then aggregated into a weighted value $U(a_j)$ and where finally the resulting index $I(a_j)$ is $U(a_j)$ rounded to the nearest integer value. The scale and measurements involved can be made even more realistic by, e.g., utilizing sub-criteria as well as more complex assessments, in terms of mixtures and comparisons and interval statements as well as distributions, along the lines of, e.g., (Danielson and Ekenberg, 2019). How this works in practice will be demonstrated in the next section.

6. Some Examples of Components of the Positioning Criteria

We will now map some tools according to the index being used. As above, we will use the criteria transparency, autonomy, consensus, and pluralism. Tables 2 and 3 show, respectively, the analyses for municipality chat rooms and political discussion boards.

Table 2: Analysis of Municipality Chat Rooms

Grading	Motivations for grading
Transparency: $>_0$	The component does not support transparency since discussions in a chat room tend to be particular and unofficial. Additionally, not all chat rooms save the chats for later viewing.
Autonomy: $>_0$	Chat rooms do not support collaboration between residents. The activity in the two municipalities we have looked at seemed very sparse, and no peer recognition, networking, etc. seemed to have occurred. However, chat rooms do not hinder this but rather do not offer any support per se.
Consensus: $>_2$	Chat rooms facilitate the ability to discuss propositions and rulings within a municipality, it also supports both municipality representatives and the municipality residents. I.e. they have a strong potential to support consensus-building.
Pluralism: $>_1$	As only a small number of representatives participate in a chat at the same time, the support for pluralism is weak. A chat room is used for discussions between individuals, so even though chat rooms can be considered as a component that acknowledges diversity and conflicts, it does not support counter-cultures or collective actions between municipality residents.

Table 3: Analysis of Political Discussion Boards

Grading	Motivations for grading
Transparency: $>_0$	The reviewed (and probably most) discussion boards are unaffiliated with decision-makers. However, political agendas, suggestions, or rulings can be discussed on discussion boards and information on issues can be shared. Due to the lack of affiliation with decision-makers, discussion boards only show weak support for transparency.
Autonomy: $>_2$	Discussion boards let their participants form collaborations and posts and especially frequent posters get peer recognition.
Consensus: $>_1$	As the political discussion boards are not affiliated to any political parties they do not have much impact on decision making in communities, but they do support creating a shared understanding of political issues. Therefore, the reviewed political discussion boards do only provide weak support for consensus.
Pluralism: $>_2$	Political discussion boards let their users easily form counter-communities and create collective actions. The boards strongly support pluralism.

First, we need a scale for the analyses. Assume that we desire the indices to be around 20 on average and that we expect an average k of about 1.2 for the $>k$ statements. Then we obtain a scaling constant α = 20/1.2 ≈ 16.7. (The particular scale does not matter and any linear transformation of this one would do.) Utilising the transformations described in the previous section, this results in the following assessments:

The components of Municipality Chat Rooms (a_1) are assigned the following surrogate numbers: Transparency: v_{12} = 0.0; Autonomy: v_{14} = 0.0; Consensus: v_{11} = 33.3; Pluralism: v_{13} = 16.7.

And for Political Discussion Boards (a_2): Transparency: v_{22} = 0.0; Autonomy: v_{24} = 33.3; Consensus: v_{21} = 16.7; Pluralism: v_{23} = 33.3.

Further assume that we establish a ranking of the importance of the characteristics, for example $Transparency >_1 Pluralism >_0 Autonomy >_2 Consensus$, resulting in the following weights: w(*Transparency*) = 0.40; w(*Pluralism*) = w(*Autonomy*) = 0.25; w(*Consensus*) = 0.10.

Note that these values are not simply assigned but a consequence of the asserted ranking and the derived characteristic weights. Consequently, the ranking then yields the indices $I(a_j)$ by

$$\bar{U}(a_j) = \sum_{i=1}^{n} \bar{w}_i \bar{v}_{ij}$$

as the sum of products $w_i \cdot v_{ij}$ and then $I(a_j)$ as $U(a_j)$ rounded to the nearest integer.

The result is that Municipality Chat Rooms receive an index $I(a_1)$ = 17 and that Political Discussion Boards receive $I(a_2)$ = 18.

One issue concerning the use of e-democracy tools such as the above ones is that a tool is not always used as intended – if we by intended mean increasing e-democracy or the participation in e-democratic processes. Just using a tool that in our analysis displays high support for information dissemination may not in the end increase e-democracy per se – it might simply be used to disseminate information to a target population for good and for bad. A tool is not inherently democratic or non-democratic, but in our model we analyse the *potential* of using these tools to support components that are usually mentioned in the literature as useful and beneficial for e-democracy (as was discussed in the literature overview above).

The example continues with two more specific e-tools:

6.1 Analysis: BottenAda

BottenAda was a software that used Bayesian statistics to try to predict the election results in Sweden in 2014.

Transparency: BottenAda supports transparency in that it visualizes the strengths of parties and coalitions of parties based on polls of polls and Bayesian analysis. By showing the likelihood of, for example, a certain party's ability to take seats in the government, it lets potential voters make more informed and/or tactical decisions on which party to support. Measure: $>_2$

Autonomy: BottenAda does not support networking, collaborating, distributing, or sharing among users. Measure: $>_0$

Consensus: BottenAda does not support Consensus per se since it only provides information on parties and coalitions rather than issues to reach consensus, without the possibility to have discussions or reach consensus on specific issues. Measure: $>_0$

Pluralism: BottenAda does not support pluralism in more than it recognizes the probable percent of votes for different parties. It does not cover different ideas or issues in its scope, and it does not support collective actions Measure: $>_0$

6.2 Analysis: Twitter

Twitter is a very well-known online social networking service where a user can post short messages, so-called "tweets", iterate others' messages, and interact.

Transparency: Twitter does not explicitly support forms sharing of data between agencies, government to citizens, and citizens to citizens, where the aim is better service, efficiency, and innovation: aggregating, competing, informing, petitioning, transacting, transmitting, voting, controlling. Implicitly it supports the aim of informing. Measure: $>_0$

Autonomy: Twitter supports forms for open-source cultures where participants typically collaborate motivated by peer recognition or other micro-rewards: networking, collaborating, distributing, and sharing. Measure: $>_2$

Consensus: Twitter does not explicitly support forms for collective decision-making or information production. Implicitly it supports some of the aspects of shared understanding, namely: opinion-forming, arguing, and agenda-setting. Measure: $>_1$

Pluralism: Twitter supports or enables activities that acknowledge diversity, inequality, and conflicts. There is some support for establishing counter-cultures and collective actions: associating, campaigning, contesting, forming groups, community building, organizing, mediating, and protesting. Measure: $>_1$

Adopting the same characteristic weights as in the example above, we obtain the indices $I(BottenAda) = 8$ and $I(Twitter) = 14$.

Similarly, various other tools can be evaluated and positioned with respect either to the strengths of the respective characteristics (such as those in Figure 1) or to the aggregated measure discussed above where also the relative importance of the characteristics can be taken into account.

For a practitioner to use an indexing method like this, a relevant set of criteria for the purpose intended has to be selected, defined, and described. Then for each participating e-democracy tool, it needs to be measured and evaluated on a scale as in Figure 3, comparing it to a base or zero tool with almost no capabilities in the dimension under consideration. The results of the comparisons can be illustrated on an index scale as shown in Figure 4. For the actual implementation, a spreadsheet should be sufficient. It could easily hold the computational formulas, thus hiding them in everyday use and eliminate the risk of making errors that could arise if performing the calculations manually.

Note that Figure 4 aims only at illustrating the methodology with a broad coverage of tools. To give a more precise picture, a much more detailed analysis would be required, which is beyond the scope of this article.

Some other dimensions (or criteria) could be valuable in such evaluations. For example, criteria for usability could be employed. It is important for the practical use of a tool that it is reasonably well-designed when it comes to the usability and accessibility of the user interface (UI). If usability is to be considered, one way of measuring the success of the UI in that respect would be to consider its affordance, i.e. how well its functionality could be inferred from the interface that it presents to the prospective intended users, some or many of which might not be extensive everyday computer users. Affordance theory, while introduced by (Gibson, 1977), has among computer scientists and computer tool designers become widely spread as a concept by (Norman, 2013).

A dimension of affordance could easily be added to the framework, as could many others depending on which goals are being set by the index makers.

Figure 4: Example of how various types of tools can be positioned on a mapping of e-democracy to an index

7. Concluding Remarks

Democracy is a multi-faceted concept and evaluating ICT tools for enhancing democracy along only one dimension can be misleading since all aspects, relevant for the context under consideration, should preferably be considered. We have, therefore, suggested an e-democracy indexing and mapping technique which is a functional approach to evaluating e-democracy tool support while taking various aspects of democracy and analysing the concept with respect to a set of dimensions. The point of departure for the exemplification in this paper has been four different aspects of democracy (transparency, autonomy, consensus, and pluralism) and for each aspect, several components needed for support of e-democracy have been identified.

The comparatively simple model has then been used as the basis for a method for conceptualizing components supporting e-democracy as well as for evaluation. The model makes use of the aspects and it is demonstrated how these dimensions can visually position different components of e-democracy. We have also suggested how to use the model for evaluating tools to support participation in these contexts and how tools for supporting e-democracy can then be measured in terms of the degree of support for the various components (aspects). If we would want to extend the geometric representation, more dimensions could be introduced and handled analogously. For instance, a three-dimensional picture showing a constrained local locus to a global one without clear boundaries could be introduced. With locus we mean whether it is a locally constrained situation (such as the citizens in a nation-state) or if the locus is more fluid and unlimited (as in the environmental movement where almost everyone that has an interest in environmental issues can take part). The index itself is insensitive to the number of dimensions but the geometrical representation becomes problematic, although it can still be made meaningful by using projections onto subspaces. In any case, the framework can support interdisciplinarity and communication with a diversity of stakeholders in a highly multidisciplinary development context. Depending on the goals, the e-democracy map can be used to assess and choose a tool to be used to meet those goals. The model can also be used as a way to reflect on if a tool can be enhanced in some way, or to see which democracy aspects a portfolio of tools is covering.

Several roads of improvement of the work are conceivable. Firstly, the scoring process in terms of how measurements are assigned to e-tools could be tuned in several ways. A first step could be to test the reliability of the assigned values by letting larger groups of researchers and practitioners redo the scoring of the samples analysed in this paper (i.e. Municipality Chat Rooms, Political Discussion Boards, BottenAda, and Twitter) and other similar tools. Another aspect concerns the normalisation of the obtained results, i.e. the scores could be weighted in order to indicate that some analysed aspects are considered to be more important than others. The framework is open by design and can easily be combined with various existing multi-criteria decision tools and tools for conflict detection and resolutions of different complexities to form a more powerful toolset. Another natural extension is to allow for a richer variety of statements, for which there exist methods within the area of multi-criteria decision making.

The evaluation model builds on the inclusion of different views of e-democracy, not seeing them as conflicting per se but rather making it possible for e-democracy tool users and developers to understand the varying degree of support a tool can display for several aspects of democracy. The model also provides a visualization of complex theories and can thus contribute to a more informed discussion on what types of democratic values are being supported in a particular e-democracy tool.

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