

On e-democracy: model and case of participatory public decision making

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Abstract

In this paper, I present various arguments on electronic democracy and focusing on participatory public decision making processes, I propose a framework for system support and discuss related research. As a case that illustrates feasibility of participatory public decision making, I present the participatory budgeting experiment in Porto Alegre, Brazil. The case is analyzed based on the proposed framework.

Keywords: electronic democracy, group decision support systems, negotiation support systems, participatory budgeting

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1. Introduction

Advances in information and communication technology (ICT) enabled a much more substantive implementation of democratic ideals: the government of the people, by the people, and for the people. The hope of involving more citizens in societal decision making in many more ways than now is rising. Electronic democracy or e-democracy articulates political and democratic procedures using modern ICTs.

Although the debate on how to implement e-democracy became active only recently, the concept of electronic democracy is not new. Early discussion on it can be found in as early as the 1980s in the work of so called futurists. Naisbitt (1982) argued that ICTs can remove time and space barrier and as a result of this, direct democracy may become feasible. Toffler (1984) claimed that advances in ICTs enable new types of voting systems through which minority groups can reflect their opinions effectively. He believed that, in the information age, the political system should focus on contrasting differences between various minority groups and benefiting from them rather than forming a majority. Becker (1993) believed that voting is the most effective democratic mechanism that allows citizen to express their opinions. He proposed to replace representative democracy with electronic plebiscite. Grossman (1995) thought ICT has greater potential to radically change political systems than telephone and TV. He argued that ICT will open a new era of participatory democracy which is distinguished from both Athenian democracy and modern representative democracy. Nguyen and Alexander (1996) expected that as cyberspace evolves, the power in real world will be divided and the modern political system will change. They believed citizen power will increase by taking over the power of agenda setting because gate keeping in cyber space does not work as effectively as in the mass-media society. Despite some differences, the ideal democracy considered in these arguments was a political system where citizens actively participate in public decision making through cyberspace.

This so called plebiscitary or substantial model of e-democracy is criticized for two major aspects (Yun 2002). First, it requires ideal citizens - citizens who have skills for using ICTs and are willing to invest their time and efforts on political activities. In such a model, required citizen participation is greater than now because citizens should be constantly involved in discussion and public decision making. Considering that the voting rates of even major elections are around 50% or even less in most developed countries, this requirement on increased participation posits significant limits. Therefore, ironically, this model may expedite separation of people from politics and public decision making (Davis 1999). Second, the argument that ICTs change the political and social system is the technology determinist perspective. The major weakness of the perspective is that it regards technological phenomena as if they are social phenomena. A new form of political organization does not exist in technology itself. Regardless of the potential in the ICTs, the outcome depends on society's capability and intention to use them (Barber 2000).

Another perspective on e-democracy, so called deliberative model, pursues enhancing representative democracy through citizens' increased participation in agenda setting and public discussion. For example, Elshитай (1987) believed that the critical element of

democracy is the process of deliberation. He concerned that, if voting is overused, deliberation may be omitted and the democratic process may be replaced by mechanic button selection. Arterton (1987) argued that the success of e-democracy lies not in technology choice, but in social choice. He believed the core value of e-democracy is in the access to information and opportunity to join the deliberation processes. Barber (2000) believed that the speed of decision making does not help democracy because democracy is naturally a slow decision making process involving deliberation, meeting, and conversation. He claimed that e-democracy should focus on participation of citizens in discussion and deliberation of public matters rather than making deterministic decisions through voting.

This so called deliberative model is related to the public sphere, argued by Habermas (1989). Habermas defined public sphere as a place where private entities would draw together as a public entity and engage in rational deliberation, ultimately reaching consensus on common affairs. He argued that the public sphere played a key role in the era of the democratic revolutions in the 18th and 19th century by enabling citizens to debate, organize, and struggle against unjust authority (Kellner 1999). The deliberative e-democracy model views cyberspace as a medium for implementing the public sphere (Poster 1995).

Although the focus was different, both plebiscitary and deliberative models share the optimistic view on the role of increased information access and interactive communication channels brought by ICTs. Some views are even pessimistic on this. Davis (1999) argued that increase in the amount of information may cause information overload and produce citizens with frustration and apathy. Customized delivery of information, which is a potential solution to the information overload problem, may make people focus on narrow issues of their interests rather than social issues. This in turn may lead to separation of people from public affairs and further reliance to active minority groups. In addition, although many information channels are available on-line, main channels are still the ones that acquired reliability off-line such as mass-media, political parties, and government organizations. In this situation, the powerful established groups may find it easy to influence and manipulate public opinions by utilizing their superior structure of systematic information transfer.

As stated so far, many viewpoints on e-democracy exist. Our view is that e-democracy is becoming a reality. Eventually, general public will be familiar with advanced ICTs and the systems based on them, like anyone can use TV and telephone without difficulty nowadays. Although there is room for improvement, it is clear that even with current technologies citizens may be involved more in the public decision making processes than they are allowed now. As for the implementation of e-democracy, I believe e-democracy does not have to focus only on either participatory decision making or participatory deliberation, since they are complimentary rather than conflicting. Good decision making follows good deliberation. Deliberation that does not accompany decision making is futile. I believe modern theory of group decision analysis and group support systems may help us to achieve both deliberative and participatory democracy model.

In this paper, focusing on the process of making decisions on public matters with citizen participation, I seek answers to some of the critical questions in e-democracy. Can people participate? How can people participate? Do people want to participate? What are the ways to efficiently and effectively participate? What is existing knowledge and what needs to be

done?

The outline of this paper is as follows. First, I propose a framework for systems supporting participatory public decision making processes and present related research. This provides partial and preliminary answers to the last two questions. Then, as a case that illustrates a feasible model of participatory public decision making, I present participatory budgeting experiment in Porto Alegre, Brazil. The case provides some important insights on the answers to the first three questions on the citizen participation dynamics. Finally, I conclude this paper discussing the research issues.

2. Framework for system support

In this section, first I present a framework for modeling participatory public decision making processes. The process can be considered as a policy making process. I present five phase model of general policy making and review it in the context of participatory decision making. Then I consider system support for these phases. Three ways of system support can be considered: *communication support*, *process support*, and *decision analytic support*. Communication support aims to removing communication barriers in participation. This is a building block of the system support and critical to increasing participation. Process support focuses on systematically directing the pattern and timing of activities, interactions, and/or content of discussion among participants. The main purpose of this is to improve productivity of collective thinking. Hence it is closely related to the deliberative e-democracy model. Decision analytic support helps participants to structure the problems and provides them with decision analysis techniques. For this, it requires formally modeling the problem and eliciting explicit preferences from the participants. Once preference elicitation is done, various approaches can be taken to create collective preferences or reach an agreement by compromises.

In the following sub-sections, these three support functionalities are reviewed in the context of the participatory policy making process model. I also select some relevant previous studies and present them.

2.1 Policy making process

The process of making decisions on public matters may be considered within the general class of policy making process, which, in turn, may be seen as five phases of interdependent political activities as follows (Dunn 1994). The five phases and activities are:

1. **Agenda setting:** This first step of policy making is to transform a social problem into a policy problem. In this phase, among the universe of social problems, some of them should be selected and posited in the context of making a policy.
2. **Policy formulation:** Consideration of technical, societal, cultural, and legal aspects, the alternatives that may solve the policy problem are identified.
3. **Policy adoption:** The generally defined policy alternatives are transformed into a

concrete policy. The policy alternative is adopted as the law or order by legislative or administrative institutes. This phase may be de-composed into the five problem solving sub-steps of *policy problem definition, policy objective definition, collection of data and information, exploration of alternatives, and analysis and evaluation of alternatives.*

4. **Policy implementation:** Administrative resources are allocated to implement the policy conforming to the requirements determined in the policy adoption phase.
5. **Policy assessment:** The government, parliament, and/or court are monitored in order to check if they conform to the legal requirements of the adopted policy.

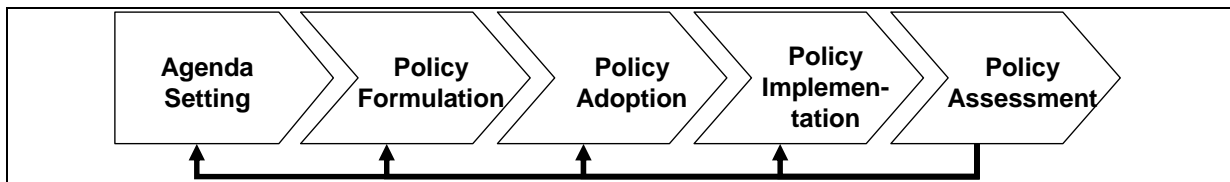


Figure 1. Five-phase framework of policy making (Dunn 1994)

Participation of the general public may increase in all of these phases. In modern democracy, typically all these phases were performed by bureaucrats and politicians with limited participation of citizens (e.g. public hearing). Due to the technical nature of the task, policy formulation and assessment may need to be done by the experts in the subject matter and policy implementation may need to be done by the institutes, limited citizen participation in agenda setting and policy adoption may be significantly improved in e-democracy. Support for participatory deliberation is more appropriate for participatory agenda setting, while support for participatory decision making is necessary for participatory policy adoption.

2.2 Communication support: removing communication barriers

In order to allow participation of citizens beside those who can attend a meeting at a specific place and at a specific time, the system supporting communication is essential. Geographical barrier in communication can be reduced by computer-mediated communication (CMC) through the web or another network. Asynchronous mode of communication allows us to overcome time barrier. Because the asynchronous communication mode can ensure the maximum level of participation, it should not be omitted in the systems supporting participatory public decision making.

Various media are available for CMC including video, voice, sound, email, instant messaging, short message services, memo, bulletin board, white board, shared workspace, virtual reality (VR) space, and so on. An important issue in communication support is to select the communication media to the participants.

Research on media richness theory may help us answer this question. The theory suggests that richness in these communication media can be determined by the degrees in availability

of instant feedback, capacity to transmit multiple cues (e.g. body language, voice tone, and inflection), natural language support, and personal focus. According to the criteria, face-to-face (F2F) communication has the highest degree of media richness and the synchronous mode CMC has higher degree of media richness than asynchronous mode.

Experimental research on media richness theory suggests that it is not always beneficial to provide the highest degree of media richness. Certain media works better for certain tasks than others and effective management should consider matching a particular communication medium to a specific task and to the degree of richness required by that task (Daft et al. 1987; Suh 1999). For example, many studies show that system supported F2F meetings result in good performance in idea generation tasks while computer-mediated meetings result in better performance in decision making tasks (Fjermestad and Hiltz 1998/1999). Ocker et al. (1998) studied four modes of communication support: F2F, synchronous distributed CMC, asynchronous distributed CMC, and combined F2F-asynchronous CMC. They found the combined F2F-asynchronous mode yields better performance in idea generation tasks than any other modes. This may indicate that F2F meetings combined with asynchronous communication support (e.g. discussion board) may be appropriate for the idea generation task such as agenda setting, while the asynchronous communication support may be appropriate for decision making tasks such as voting on policy alternatives.

There are extensive amount of experimental studies on the effect of CMC, but not all of them found significant difference and some of them resulted in conflicting outcome (Fjermestad and Hiltz 1998/1999). This indicates existing knowledge should be interpreted carefully considering the context. In addition, in participatory public decision making processes, not all participants may use the same communication mode – for those who attend the meeting, it may be F2F-asynchronous, but for those who did not attend the meeting, it becomes just asynchronous. Such a heterogeneous situation opens a new venue of CMC research.

2.3 Process support: systematically directing interactions and/or content of deliberation

Most policy making activities involve groups. In order to improve the productivity of group work, the process support is critical and process support requires some form of facilitation. Facilitation may impact relationship development, participation, issue-based conflict, interpersonal conflict, negative socio-emotional participation as well as satisfaction and quality of decision of the group (Miranda and Bostrom 1999). As presented in Table 1, there are various models of the facilitator. Facilitation may be performed by the internal leader of the group, just a member of the group, external one or in even a system. The facilitator may focus on interactions or content facilitation. The facilitation may be restrictive or flexible. A facilitator may also provide training on the system and the process. In any case, resolving socio-emotional issues is an important role of the facilitator (Kelly and Bostrom 1998). In terms of timing of intervention, a facilitator may engage in activities before, during, and/or after the meeting.

Table 1 Model of the facilitator

Role	Facilitator	Timing of facilitation
- Structuration of the task	- Internal leader	- Before meeting
- Guide content	- A group member	- During meeting
- Guide interactions	- External facilitator	- After meeting
- Handle socio-emotional issues	- System	
- Training		

In the environment of F2F group meetings supported by the system (so called decision-room), the facilitator typically provides technical support such as training and answering the questions as well as process support. In this case, the role of the facilitator is critical because the facilitator promotes effective use of the system. In the synchronous distributed environment, the role is simpler because technical support function is usually not provided by the facilitator.

In the asynchronous distributed setting, the role of a facilitator can be more complex. First, a meeting in the asynchronous mode may last days, weeks, or even months. In addition, interactions of participants may happen whenever it is convenient for them and messages sent by a participant may be received by other participants in a different order. Further, because participants have more freedom to work individually and interactions are less frequent and immediate, coordinating participants is much harder (Tung and Turban 1998).

Turoff et al. (1993) suggested there are four group coordination methods as follows:

- **Parallel:** individuals approach the problem independently
- **Pooled:** individuals approach the problem independently and a group produces an outcome according to a standard procedure such as group vote
- **Sequential:** all group members undertake the problem-solving in a sequential manner
- **Reciprocal:** changes made in one part forces other group members to re-consider other parts

They argued that a group supported by the synchronous communication mode typically uses a self-imposed sequential method of coordination, because typically the group uses agendas which force participants to go through the process step-by-step.

When the asynchronous mode is used, coordination mechanisms should be more explicitly

considered. For sequential coordination, agenda should be defined and enforced. For reciprocal coordination, frequent communication is required in order to let individuals to reconsider earlier activities and make necessary adjustment. For pooled coordination, there should be a signaling mechanism for indicating that individual approaches should be finished and the standard procedure should be started (Tung and Turban 1998). Considering the nature of the communication mode and difficulty in group coordination, I expect system facilitation or system-aided facilitation will play a crucial role in the asynchronous distributed environment.

Beside facilitation, various tools supporting group activities can be provided to the participants including tools for divergence (e.g. brainstorming), convergence (e.g. idea selection), exploration (e.g. in-depth analysis), consensus (e.g. voting), team writing, and alternative evaluation (Briggs et al. 1997/1998). Effectiveness of these tools has been studied in group decision support system (GDSS) research. Various models and hypothesis under different process contextual factors such as task and group structure have been tested through laboratory and field experiment. Studies suggest that the nature of the task moderates the usefulness of the tools. For example, Lam (1997) found GDSS improves decision quality in disjunctive and conjunctive tasks, while no significant differences between F2F and GDSS users were found in additive tasks. Many studies consistently showed that efficiency may become lower (i.e. takes longer time) when GDSS is used for process support. In terms of group structure, many studies found anonymity encourages generating ideas and identification motivates more responsible actions (Fjermestad and Hiltz 1998/1999).

Fjermestad and Hiltz (1998/1999; Fjermestad and Hiltz) provided a comprehensive review of the experimental and field research on GDSS focusing on the process support. A good review of distributed GDSS and impact of facilitation can be found in (Tung and Turban 1998) and (Miranda and Bostrom 1999). The outcomes of these studies may help develop systems for participatory public decision making with less social cost incurred by trials and errors.

2.4 Decision analytic support: providing techniques for structuring

Because the policy adoption phase can be decomposed into sub-steps of the problem solving activities, group multi-criteria decision analysis (MCDA) approach can be especially appropriate and useful. MCDA is originally designed to assist a single decision-maker facing the problem of comparing discrete alternatives based on explicit multiple criteria. MCDA models the decision making problem with the following elements which can be described as follows:

- *Alternatives* $A = \{a_i, i = 1, \dots, m\}$: actions which can possibly solve the problem
- *Criteria* $C = \{c_i, i = 1, \dots, n\}$: aspects on which the alternatives are assessed

- **Weights** $W = \{w_i, i = 1, \dots, n\}$: assessment of the relative importance of the criteria
- **Criteria evaluation** $v_i : (a_i, c_i) \rightarrow R$: assessment of the alternative on a criterion
- **Alternative evaluation** $v : (a_i, C, W) \rightarrow R$: assessment of the alternative considering the weights assigned to the criteria and criteria evaluation

The definitions above implicitly assumes additive model where evaluation of an alternative a_i can be expressed as follows

$$v(a_i) = \sum_{i=1}^n w_i v_i(a_i)$$

When applying the individual-oriented MCDA tools, the natural first step is to determine whether the group agrees on the definitions of these elements or not. For the latter case, Belton and Pictet (1997) suggested three methods to reach the group definition as follows:

1. **Sharing**: The group behaves as a single decision maker. Sharing aims to obtain a common element by *agreement*, through a discussion of the views and the negotiation. Sharing tries to reduce the differences by explicitly discussing their cause
2. **Aggregation**: Individual preferences are aggregated. Aggregating aims to obtain a common element by *acceptance*, through a vote or calculation of a representative value. Aggregation tries to reduce the differences without explicitly discussing their cause.
3. **Comparing**: Individual preferences obtained using a common approach are compared and form the basis for discussions or negotiations. Comparing aims to determine elements individually first and use them as a basis of the final agreement. Comparing acknowledges the differences without necessarily trying to reduce them.

Belton and Pictet (1997) focused on the classification of the cases rather than the methods of aggregation and the steps after adopting comparing. Extending their work, I suggest a decision analytic framework for participatory public decision making processes as in **Figure 2**. The group may not have an agreement on the problem definition, objective, alternatives, and criteria. In such a case, the group may use process support explained in the previous section for the common definitions of these elements. The individuals are likely to have different opinions on weights (w_i 's) and criteria evaluation (v_i 's). Sharing, aggregating, or comparing may be used in this case. Note that different approaches may be taken for each individual weight (w_i) and criteria evaluation (v_i). For example, w_i may be determined by sharing while w_j may be determined by aggregation. The same for v_i and v_j .

When only sharing and aggregating approaches were used in to obtain group definition of the elements, the group preferences can be directly constructed from them. However, adopting comparing for at least one weight or evaluation leads to different alternative evaluations by individuals. There can be two ways of making a group decision with different individual evaluations: preference aggregation and negotiation. In the following subsections,

I discuss them in detail.

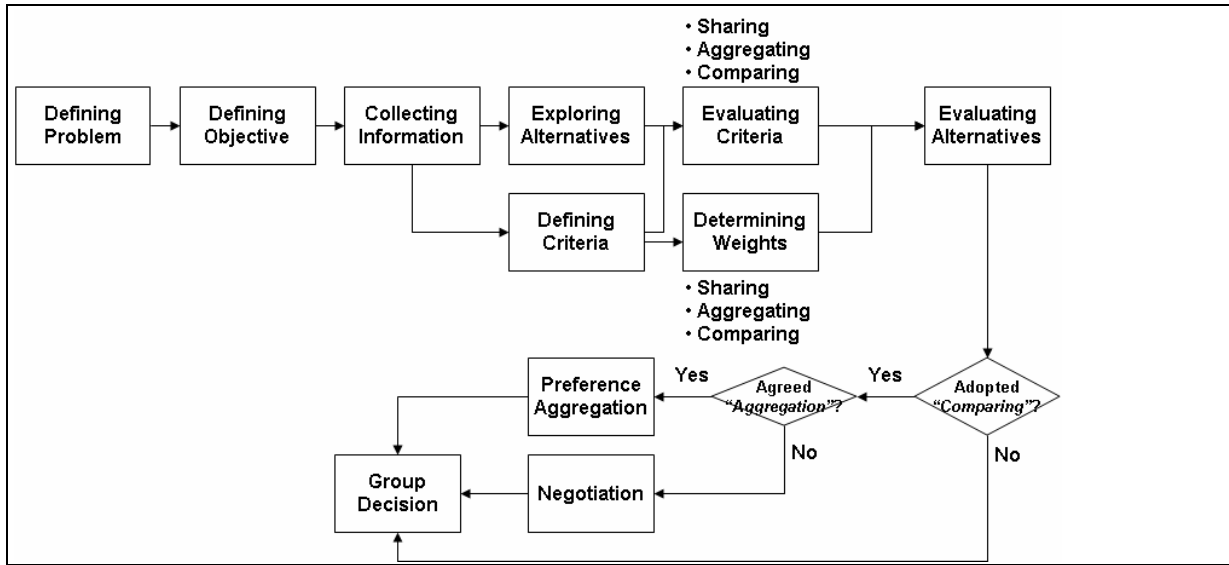


Figure 2. Framework for group decision analysis support

2.4.1 Preference aggregation models

One approach of preference aggregation is to collect individual’s ranking on the alternatives and create group’s ranking on them. This can be formally defined as follows. Assume there are a set of n individuals $I_i, i = 1, 2, \dots, n$ and set of m alternatives $A = \{a_j, j = 1, 2, \dots, m\}$. Let P_i denote each individual I_i ’s complete preferential order of A and P_G denote group’s complete preferential order of A . Preference aggregation is the function f such that

$$P_G = f(P_1, P_2, \dots, P_n)$$

Note that, when sharing is used for both weight and criteria evaluation, $P_i=P$ for all i , and $P_G = P$.

In the non-trivial case (i.e. $n \geq 2$ and $m \geq 3$), it is well known that there is no f that satisfies the following three reasonable properties (Arrow 1951; Mas-Colell et al. 1995).

- **Pareto efficiency (PE):** if $P_i(a_j, a_k) = a_j \phi a_k$ for all I_i , then $P_G(a_j, a_k) = a_j \phi a_k$
- **No dictatorship (ND):** There is no individual I_i such that $P_G(a_j, a_k) = a_j \phi a_k$ if and only if $P_i(a_j, a_k) = a_j \phi a_k$
- **Independence of irrelevant alternatives (IIA):** for two preference profiles (P_1, \dots, P_n) and (P'_1, \dots, P'_n) such that, for all individuals I_i , alternatives a_j and a_k have the same order in P_i and P'_i , alternatives a_j and a_k have the same order in $f(P_1, \dots, P_n)$ and $f(P'_1, \dots, P'_n)$

This mathematical reasoning known as Arrow's impossibility theorem should not be interpreted as *every ranked voting method is flawed, or the only voting method that isn't flawed is a dictatorship*. It rather states that one can not expect preferential coherence from the group preferences formed by aggregating individual preferences as one may expect from preferences of an individual (Mas-Colell et al. 1995). Creation of group preferences by aggregation of individual preferences has been studied extensively in social choice theory. Many studies focused on possibility and impossibility of the social choice rule satisfying various axioms, especially relaxing the IIA axiom.

Voting is one of the most commonly used mechanisms to make a group decision based on the aggregated individual preferences. Voting is a special class of the general preference aggregation model that can be modeled by the following function:

$$g(P_1, P_2, \dots, P_n) \in A$$

Hence, Arrow's impossibility theorem still holds in the voting. In voting, one of the most important issue is whether the mechanism can be manipulated. Gibbard and Satterthwaite (Gibbard 1973; Satterthwaite 1975) proved impossibility of satisfying PE, ND and another important axiom called strategy-proof defined as follows

- **Strategy-proof (SP):** there is no individual I_i such that $P_i(g(P_i', P_{-i})) \not\phi P_i(g(P))$ where $P_i' \neq P_i$

The strategy-proof means it is impossible for one to obtain a favorable outcome by manipulating its preferences considering others' preferences. Therefore, Gibbard-Satterthwaite theorem suggests either one of PE and ND principle should be compromised to achieve SP in general cases. Beside IIA and SP, there are many other criteria for measuring voting systems including majority, participation, monotonicity, Condorcet, etc. Various voting mechanisms were proposed including binary (e.g. approval voting), ranked (e.g. Borda count), pair-wise comparison (e.g. Condorcet method), rated (e.g. grade voting), and so on. An extensive review of evaluation criteria, various voting mechanisms, and their evaluation based on the criteria can be found in Cranor(1996). However, it should be noted that the adoption of a voting mechanism should consider accountability, process complexity, form design (i.e. user interface), and public acceptance as well as satisfaction of logical criteria.

Keeney(1976) proved that when preferences are represented by cardinal utility, that is P_i is $\{u_i(a_j) \in R, j = 1, \dots, m\}$, there exist the following f

$$u_G = f(u_1, u_2, \dots, u_N)$$

that satisfies PE, ND, and IIA. He also showed that the following preference aggregation rule

$$f(u_1, u_2, \dots, u_n) = \sum_{i=1}^n k_i u_i \text{ where } k_i \geq 0, i = 1, 2, \dots, n \text{ and } k_i > 0 \text{ for at least two } k_i\text{'s}$$

can satisfy Arrow's axioms regardless under certainty and uncertainty.

Keeney's result indicates that eliciting cardinal utility from individuals and summing them, possibly with different weights assigned to them, can be a better preference aggregation method than voting. However, there are weaknesses in this approach. First, in order to satisfy three axioms can be satisfied, it requires inter-personal utility comparison. In addition, from the perspective of the practice, people need to specify the cardinal utility, which can be often inaccurately specified by people.

2.4.2 Negotiation models

The typical negotiations in the participatory public decision making process is many-to-many negotiations considering multiple issues. For the n -party negotiation, $n \times (n-1)$ communication channels should be established and every individual has to handle $(n-1)$ channels. Considering coordination loss when n becomes large, mediated negotiations is a reasonable choice since it can reduce the number necessary channels from $n \times (n-1)$ to n and each individual may need to handle only one channel with the mediator.

The mediation may be done by a human being or a system. Considering the communication and information processing load, for a human mediator to perform mediation, n needs to be a manageable number and system support to the facilitator will be crucial. In this case, the structure of negotiation will become similar to one-to-many negotiation.

Considering the potential of large participation in participatory public decision making processes, whether it be a human mediator or a system mediator, it is important to have analytic support in order to find out efficient potential solutions for making recommendations. Bargaining theory provides useful models for this purpose.

Bargaining theory formally defines the bargaining problem and solution as follows. Assume there are n individuals and m alternatives. Let $S \subseteq R^n$ denote the set of utilities assigned to the set of possible alternatives. In other words,

$$S = \{(u_1(a_j), u_2(a_j), \dots, u_n(a_j)), j = 1, \dots, m\}$$

Disagreement point or status quo point $d = (d_1, d_2, \dots, d_n)$ is a vector of the utility levels which individuals will receive when there is no agreement. Bargaining problem is defined as (S, d) and bargaining solution is to find out a point $f(S, d) \in S$ such that $f(S, d) \geq d$ satisfying some fairness concepts. Various bargaining solutions satisfy different fairness criteria (Nash 1950; Kalai and Smorodinski 1975). Thomson(1994) provides an extensive overview of bargaining solutions and properties which those solutions satisfy.

Those bargaining solutions are interpreted as the solutions which a neutral and fair third

party mediator would recommend. Let $R(f(S, d))$ denote the set of responses to the recommended solution $f(S, d)$ from all parties involved. Mediation processes based on bargaining theory can be generalized by the following algorithm:

Initialization: $S_0, d_0, f_0, t=0$

Iterate until a stopping criterion is met

Suggest $f_t(S_t, d_t)$

Collect $R_t(f_t(S_t, d_t))$

$t = t+1$

Update S_t, d_t, f_t

Note that the iteration does not have to stop when $R_t(f_t(S_t, d_t))$ was an agreement (i.e. every individual agrees with $f_t(S_t, d_t)$). It is because even if every one agrees, there may be better solutions hence it may be improved.

Hence, it is not necessary that f_t generates a solution that satisfies non-dominance criterion (i.e. Pareto efficiency) because the solution is not the final arbitration outcome but an intermediate one which can be further improved in the later stages. Therefore, it is the properties of the limiting solution to which attention should be paid.

Various mediation methods can be considered depending on how to update S_t, d_t based on $R_t(f_t(S_t, d_t))$ and how to choose f_t and update f_t . For example, one may update S_t, d_t only and use the same bargaining solution f for every step. One may choose f that yields Nash's solution or Kalai-Smorodinsky's solution. One may also adopt different bargaining solutions satisfying different properties at each step of iteration.

In order to encourage and improve deliberation, I believe it is important to ensure communication between parties, especially before and after collecting responses R_t for collective and continuous elaboration of solutions as close as possible to the interests of all the involved parties.

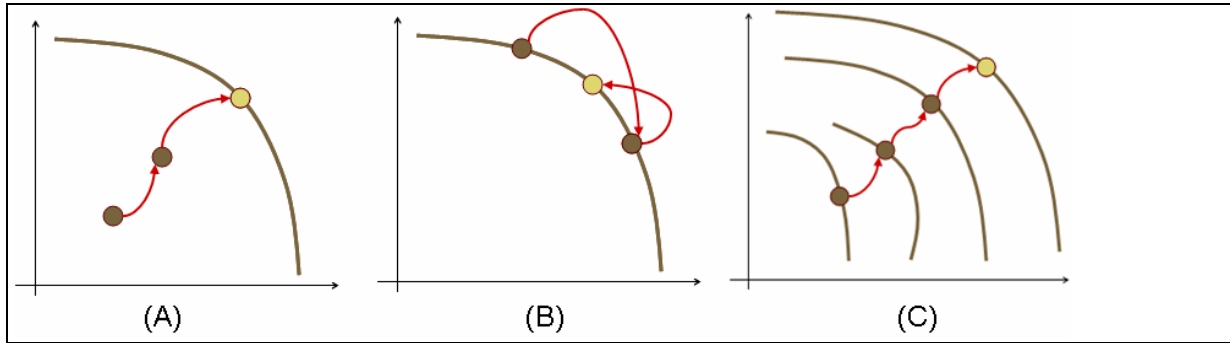


Figure 3. Three types of mediated negotiation processes represented in the utility space (2-party case)

Figure 3 illustrates some of the possible types of mediation in the utility space. (A) shows the method based on updating d while S remains the same. This method can be interpreted as helping the negotiators to achieve efficient agreements in a fair manner. The Balanced Increment Method (BIM) or Single Negotiating Text (SNT) presented in Raiffa et al. (2002) corresponds to this case. (B) is the case in which f_t used in each iteration yields non-dominant (i.e. PE) solution. This approach focuses on improving process efficiency, in the sense that the improvement step present in (A) is omitted and obtained agreement is always non-dominant. The approach proposed by Rios-Insua et al. (2003) corresponds to this type. In (C), both S and d are changing in each step. This can be interpreted as helping the negotiators to learn and realize and size the opportunities. This can be achieved in different ways. When the preferences are well-defined, this can be achieved by introducing options or issues that were not considered in the previous stage. When the preferences are not well-defined, this can be done by gradually identifying the preferences. The approach proposed by Ehtamo et al. (2001) corresponds to this case.

Bargaining theory requires individuals to fully reveal their preferences to the neutral third party. This has been considered as rather unrealistic assumption and the limit of the theory when it comes to application in practice. However, Recent advances in information and communication technologies allows implementing systems that protect privacy of preference information. Beside technical development, wide social acceptance of cryptography and other security technologies can encourage full open to the intermediary disclosure (FOTID). Under the FOTID assumption, a system founded on bargaining theory can play a significant role as an impartial arbitrator or mediator who resolves the conflict by suggesting solutions that fairly distribute the profit from the cooperation (Rios Insua et al. 2003).

3. A case of participatory public decision making: participatory budgeting (PB)

An interesting example of participatory public decision making procedure is participatory budgeting (PB), which is the process of allocating budget to various public projects with high degree of citizen involvement. The first report on successful PB implementation is from Porto Alegre, Brazil, a city with 1.3 million population. Nowadays, more than 240 municipalities in Brazil and other countries including Ireland, Canada, India, South Africa, and many south

American countries are practicing PB (World Bank; UN-HABITAT 2004). United Nations and World Bank recommended PB as one of the recommended policy practices for improving transparency, reflecting minority interests, and educating the public, and so on.

Implemented PB processes vary by municipalities due to different social, political, and cultural contexts. For example, according to the survey of 103 Brazilian municipalities in 1997-2003, the proportion of capital budget debated through the PB ranges from less than 10% to 100% (15% of them with less than 10% and 21% of them with 100%) . In some cases, participation is allowed only through organized communities such as unions, political parties, churches, and housing association (UN-HABITAT 2004).

Despite differences, the PB process implemented in Porto Alegre is a good representative case because, first, it has been a benchmark or a reference of many PB implementations, and second, it has the longest history (15 years). In the next section, I present the detailed description of the PB process in Porto Alegre, decision model, and lessons learned from the experience.

3.1 PB process in Porto Alegre, Brazil

PB in Porto Alegre is based on three basic principles. First, all citizens are entitled to participate. Second, direct and representative democracy rules are combined. Third, investment of resources is decided according to an objective method, so called “general criteria”, which are determined by participation, and “technical criteria”, which defined by the executives considering legal, economic, and technical feasibility.

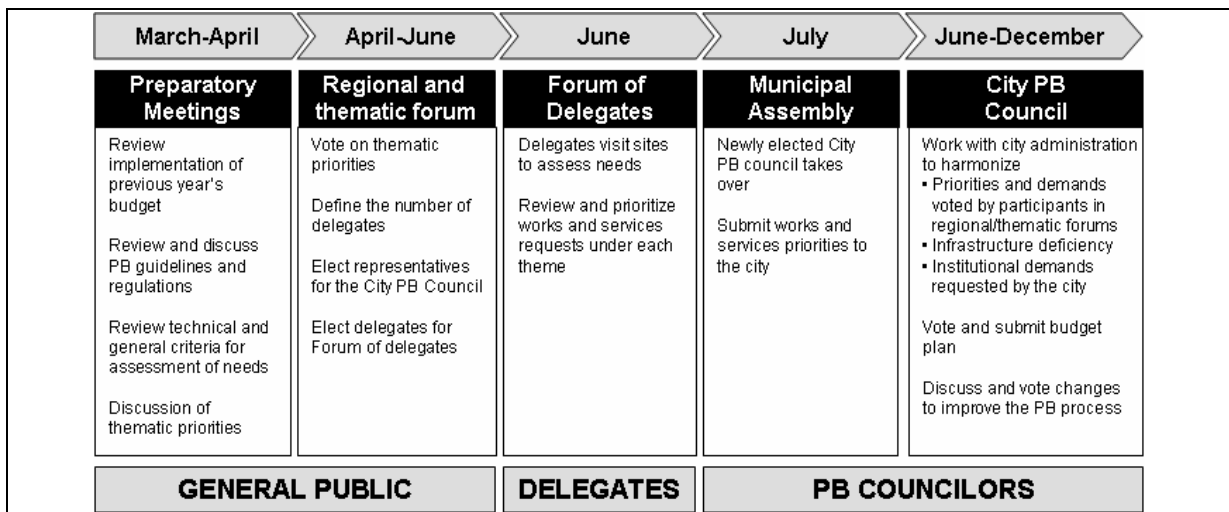


Figure 4. Participatory budget cycle of Porto Alegre: simplified version of the figure in (Center for Urban and Development Studies 2004)

The PB process in Porto Alegre has been modified many times during the 15 years of practice. Reflecting this, the PB process in Porto Alegre described in literature is slightly different. De Sousa Santos (1998) describes the PB cycle as of 1996 roughly as follows.

The first step of the PB process is mobilization of community. Various media are used for this including local press, radio, TV, vehicle with speaker, mails, posters, pamphlets, public and cultural institutions such as schools and churches. Next, the first round of regional (i.e. territorial) and thematic (i.e. issue specific) forums are held in March or April. In 1996, there were 16 regions and 5 thematic areas. In the forums, municipal government reports on previous year's investment plan and presents current year's budgeting criteria. Community assesses previous year's investment plan and elects some of the delegates in proportion to the number of attendants of the meeting.

After the first round forums, in March through June, there are intermediate meetings and forums of regional and thematic groups. In this intermediate stage, priority demands in regional and thematic areas are selected. Also, remaining delegates are elected in proportion to the number of individuals attending the intermediate meeting.

In June and July, there is the second round of regional and thematic forums. Government gives account of expenses and expected income, and all the 16 regions and 5 thematic areas hand in demands and priorities. In this round, two councilors and two substitutes for every region and thematic area are elected as participatory budgeting councilors. The new PB council is composed of representatives from government and organized communities as well as elected councilors.

In the later stages, the PB councilors and the government define the detailed budget proposal in collaboration. In July and August, the newly inaugurated PB council decides the agenda. Courses and seminars on public budgeting are offered to the councilors. In August, government drafts the budget proposal rendering compatible community and institutional demands and priorities. In August and September, the PB council discusses criteria for resource allocation and votes on the proposed budget. In September, the PB council and government submit budget proposal together to the legislative body. In October and November, the details of investment plan for every region and thematic area are discussed. The legislative body votes on budget proposal by November 30. The PB council supervises the voting process. Until the new PB council is inaugurated in July next year, PB council meets for special discussion. The elected PB councilors play the role of connecting their communities and the PB council - they deliver voice of community and transmit knowledge and information they acquired in the PB council to community.

As of 2001, 14.22% of the total budget of Porto Alegre is allocated to capital investment (corresponding to US\$ 179,000,000) and all of this is determined by PB (Center for Urban and Development Studies 2004).

3.2 Determination of budget matrix

The budget matrix, which specifies the proportion of budget allocated to a specific issue (i.e. theme) for a specific region, forms the core of the PB process. The matrix is determined by the criteria and weights on the criteria which are discussed and announced in the preparatory stage of the PB process. Some values of the criteria are assigned by the experts or technical assessment, while others are determined by group decision of citizens such as voting.

In Porto Alegre, as of 1997, there were 13 themes: sewage, housing, pavement, education, social assistance, health, transportation and circulation, city organization, leisure areas, sports and leisure, economic development, and culture. Three criteria used in Porto Alegre were the total population in the region (weight 2), lack of public services and/or infrastructure in the region (weight 4), and thematic priority elected in the region (weight 5). The values of two criteria (total population in the region and lack of services/infrastructure) were determined by technical assessment and the value of one criterion (thematic priority elected in the region) is determined by voting. Table 2 shows the criteria used in Porto Alegre.

Table 2. Evaluation of Criteria in Porto (Center for Urban and Development Studies 2004)

Total population in the region (weight 2)		Lack of public services and/or infrastructure in the region (weight 4)		Thematic priority elected in the region (weight 5)	
~25,000	Grade 1	76%~	Grade 1	Fifth or more	Grade 0
25,001 ~ 45,000	Grade 2	51%~75.99%	Grade 2	Fourth priority	Grade 1
45,001~90,000	Grade 3	15%~50.99%	Grade 3	Third priority	Grade 2
90,001~	Grade 4	0.01~14.99%	Grade 4	Second priority	Grade 3
				First priority	Grade 4

Table 3 shows an example of determining the proportion of the budget allocated to themes and regions. Table (A) shows that theme 1 will be allocated 8.1 % of the budget because the total score of all themes received from all regions is 5400 and theme 1 received 440 (440/5400 = 8.1%). Table (B) shows the allocation of budget for theme 1 to 16 regions. For example, region 1 has population less than 25,000, lacks 60% of infrastructure, and voted theme 1 as the theme with third priority. Region 1's score is calculated as $1 \times 2 + 3 \times 4 + 2 \times 5 = 24$ and therefore it will be allocated $24/440 = 5.5\%$ of the budget allocated to theme 1. Therefore, total percentage of 0.44% (0.081×0.055) will be allocated to region 1 for theme 1.

Table 3. Determination of budget proportion allocated to themes and regions

Theme	Total score from 16 regions	Proportion	Region	Criterion 1 (Weight 2)	Criterion 2 (Weight 4)	Criterion 3 (Weight 5)	Score	Proportion
1	440	8.1%	1	Grade 1	Grade 3	Grade 2	24	5.5%
2	360	6.7%	2	Grade 2	Grade 4	Grade 3	35	7.9%
...
13	380	7.0%	16	Grade 4	Grade 2	Grade 1	21	4.8%
Total	5400	100%	Total				440	100%

(A) Determination of thematic priority

(B) Determination of regional priority for theme 1

This matrix works as a budget envelope. Each theme is composed of sub-themes. For example, the sub-themes of the housing theme include land legalization, relocation, urbanization, and housing construction. The final budget allocation needs more consideration on the details. The finalization is done by collaboration of the PB council and the government, reflecting thematic guidelines and government needs beside regional

priorities. Citizens can participate in this process through the meetings with PB councilors representing their region or communicating with the government through the Internet.

3.3 Analysis of PB in Porto Alegre based on the proposed framework

From the perspective of the policy making process, PB in Porto Alegre can be described as follows. In the agenda setting phase, community needs and ideas on the projects are discussed in the citizen forum. Citizens determine priorities on these projects and themes, which are notified to the government. In the policy formulation phase, the government decides many elements of the budget allocation problem including the regions, thematic areas, the rules of aggregating priorities, and the technical/ legal/ economical guidelines. Some of these tasks are done in consultation with the PB council (e.g. determining thematic areas) while some of them are not even clearly announced to the public (e.g. technical/ legal/ economical guidelines). In the policy adoption phase, first, the budget matrix is determined based on the priority elected by citizens and based on other criteria determined in the policy formulation phase. Reflecting the needs identified in the agenda setting phase, the details of the budget investment plan are determined in collaboration by elected PB councilors and government representatives. In the policy execution phase, there is little participation of citizens. In the policy assessment phase, the budget allocation and execution are reviewed by the PB council and reported to the citizens at the forums. To summarize, in the Porto Alegre case, phases in the policy making process are done with different degree of citizen participation. Citizen participation is emphasized in agenda setting, policy adoption, and policy assessment phases.

As for communications, most of the communications were face-to-face synchronous communications such as large group town hall meetings (more than 100) and small and medium sized group meetings (less than 100). Traditional uni-directional media (e.g. local press, radio, and TV) were used to mobilize the community. No system support is provided except for the Web sites where citizens can express their opinions.

As for the process, the official meetings or forums were performed with a facilitator typically representing the government. The facilitator is reported to provide all the roles listed in Table 1 (de Sousa Santos 1998). Considering the nature of the synchronous F2F meetings and voting, sequential mechanism is supposed to be used for group coordination at the high level process, and pooling is used in part to finalize priority assigned to the themes. The profile of the participants explained in the previous section show that the groups were highly heterogeneous and ad hoc. There was no system support in process also.

As for the group decision analysis, sharing, aggregating, and comparing were all used. Problem definition (i.e. budget allocation) and objective (i.e. fair budget allocation proportional to the needs) were shared in the sense that there were not main controversial issues recognized by the citizens. Information such as potential projects, benefit/ cost/ risk assessment of the projects, the lack of infrastructure/service in the region, and population in each region, was collected from different parties but all participants shared it. Definition of the three criteria (population, the lack of infrastructure/service, and priority) and the weights assigned to them were shared by all participants. As for criteria evaluation, evaluation of two criteria (population and the lack of infrastructure/service) was shared.

However, within a region, priority of the theme was selected by voting of the residents in the region (i.e. aggregation). Each region starts with different priorities in the themes (i.e. comparing). The proportions of the total budget allocated to the themes and the proportions of the thematic budget allocated to the regions are calculated by the rule of budget matrix calculation (i.e. preference aggregation). Figure 5 visually describes the analysis of the PB process in Porto Alegre.

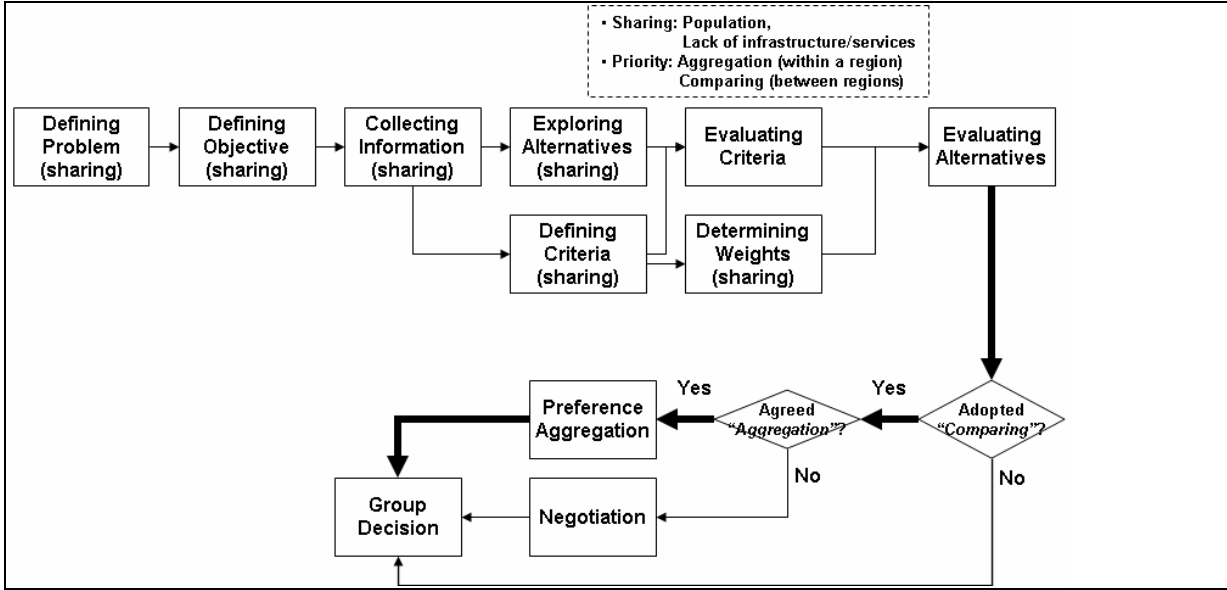


Figure 5. Group decision analysis model used in Porto Alegre

The rules of determining the budget matrix presented in the previous section is the preference aggregation method. It can be generally modeled as follows. First, let a denote the number of criteria, b denote the number of groups, c denote the number of themes, w_i denote weight on criteria i , and v_{ij}^k denote group j 's evaluation of criteria i for theme k .

When the total budget to be allocated by PB is B , budget allocated for theme k , B_k , is

$$B_k = B \times \frac{\sum_{j=1}^b \sum_{i=1}^a w_i v_{ij}^k}{\sum_{k=1}^c \sum_{j=1}^b \sum_{i=1}^a w_i v_{ij}^k}$$

When there is a criterion i^* which is region's valuation of priority on the theme, B_k may be determined by purely on the criterion as follows

$$B_k = B \times \frac{\sum_{j=1}^b v_{i^*j}^k}{\sum_{k=1}^c \sum_{j=1}^b v_{i^*j}^k} \text{ where } i^* \text{ is the criterion of priority}$$

Budget for theme k allocated to group j , B_{kj} is determined by

$$B_{kj} = B_k \times \frac{\sum_{i=1}^a w_i v_{ij}^k}{\sum_{j=1}^b \sum_{i=1}^a w_i v_{ij}^k}$$

The matrix $[B_{kj}]$ constructs a budget matrix. The budget matrix establishes a structure of public expenditure and investment, assuring regions with greater needs receive a greater budget envelope.

3.4 Lessons learned from PB experience

In terms of participation, the number of participants was only 628 in 1990, but as of 2000 it became 14,408 (de Sousa Santos 1998). Considering the total population in the city was 1,360,033 in 2000, the proportion of participation is still low (less than 1%) but encouraging fact is that it has grown steadily over the years as the impact of PB becomes real and the importance of participation is recognized.

An interesting observation is on the profile of the participants. More participation can be found from the group of people typically under-represented in the established political system such as people with low level of education (64.1% has education of primary school or less and 12% has college level education) and with low income (40% from the minimum wage income group and 30% from the two to four times minimum wage income group). Interestingly, however, the profile of elected councilors was quite balanced (40% was primary school or less, 30% had college level education) (CIDADE). As for the repetitive participation, the first time participation rate was 48.5% in 1995, and it was 47.5% in 2002 (CIDADE), indicating continuous inflow of new participants.

In Porto Alegre, thematic priorities have changed reflecting changes in demands with priority. Table 4 shows three themes with high priority determined by the votes aggregated from all regions. The table indicates paving, housing, and basic sanitation were recognized as high priority demand by the citizens during the 11 year period (1992-2002). During the 15 years of PB practice (1989-2003), significant achievements have been observed regarding these themes. Deficit of paved roadways was reduced from 690km in 1998 to 390km in 2003. The average number of housing units produced locally doubled from 494/year to 1000/year. The percentage of dwellings with access to treated water rose from 94.7% in 1989 to 99.5% in 2002. The percentage of liquid waste that is treated went from 2% in 1989 to 27.5% (UN-HABITAT 2004).

Table 4 From (Center for Urban and Development Studies 2004)

Porto Alegre: Participatory Budgets: Thematic Priorities			
Year	1 st Priority	2 nd Priority	3 rd Priority
2002	Housing	Education	Paving
2001	Paving	Housing	Basic Sanitation
2000	Housing Policy	Paving	Health
1999	Basic Sanitation	Paving	Housing Policy
1998	Paving	Housing Policy	Basic Sanitation
1997	Housing Policy	Paving	Basic Sanitation
1996	Paving	Basic Sanitation	Land Use Regulation
1995	Paving	Land Use Regulation	Basic Sanitation
1994	Land Use Regulation	Paving	Basic Sanitation
1993	Basic Sanitation	Paving	Land Use Regulation
1992	Basic Sanitation	Education	Paving

Source: Municipality of Porto Alegre (See Annex III)

This outcome can be interpreted as indication of effective decision making when the budget decisions are made by participation of the citizens: money for public works is likely to be spent where citizens feel it is most needed. Beside efficiency, there are more positive outcomes. Some of them are

- **Education:** Citizens can learn more about their neighborhood, problems, and potential solutions and their expected benefits and limitations.
- **Satisfaction:** Citizens are more satisfied with the process and decision which they participated in.
- **Commitment:** Citizens who are satisfied with processes and decisions are more committed to implementation.
- **Transparency and anti-corruption:** Transparent decision making processes prevent corruption in decision making.
- **Equality:** The poor tend to participate more than the rich and spurs investments in low-income areas.
- **Budget balancing:** Participatory budgeting typically increases spending on investments and reduces expenditures on government personnel.

There exist arguments against PB and the followings are some of them (CIDADE).

- **Populism:** The governing political party may use the budgeting process to build popular support and improve its re-election prospects, negating the importance of expertise and coherent planning. At the same time, power balance may be skewed because legislative bodies lose power when popular assemblies play a large role in the budget process.
- **Short-term oriented:** Long-term goals may be ignored in favor of more immediate

neighborhood needs.

- **Competition among neighborhoods:** Bounded to the regions, citizens may have little solidarity or understanding of the city as a whole.
- **Skewed representation:** Only the minority with intense needs or citizens with enough time may participate in the process.
- **Co-optation:** Although the final decisions are made by authorities, citizens are less likely to criticize the system because citizens perceive them as stakeholders in government decisions.

4. Conclusion

At first, ICT's primary role in democracy was considered as reducing the cost of voting and therefore enabling more frequent voting on more issues. Later, its potential has been considered from the perspective of enhancing deliberation processes. The contribution of this paper can be found in an effort to integrate these plebiscitary and deliberative perspectives. In section 2, viewing the participatory public decision making processes as a policy making process, I suggested a framework of system support for communication, collective deliberation processes, and group decision making.

In order to examine the feasibility of participatory public decision making model and to learn from experiences, I presented participatory budgeting experiment in Porto Alegre. The case shows us that participatory decision making is not only possible but may lead to effective collective decision making. The experience tells us that the level of citizen participation is strongly dependent on the perceived impact of their participation. The analysis of the case from the perspective of decision analytic model shows us one way how the group MCDA approach can be used in large scale group decision making where not all the participants may have understanding of the group MCDA model and where not complete preferences of the participants are elicited. However the case also shows that the participatory public decision making can be implemented not without a problem. Lessons learned in the experience was summarized in section 3.

PB in Porto Alegre used no CMC or systems for process and decision analytic support. This indicates there is still a long way ahead to e-democracy. Using the systems in the participatory public decision making processes may improve them but may also cause more problems, and for now, it is not completely known what they could be.

The body of knowledge accumulated in the group decision and negotiation support systems can certainly provide guidelines for developing the systems supporting participatory public decision making and reduce the social cost of trials and errors. However, this knowledge is context dependent and coming from the simplified laboratory settings. This poses challenges in using knowledge acquired in negotiation and group support system research. I identify six major challenges in developing systems supporting participatory public decision making processes as follows:

1. ***Non-expert users with diverse profiles:*** While the users of decision support systems are usually assumed to be specialists, many citizens are not familiar with decision analytic model and decision support systems. In addition, citizens have different cognitive capabilities, interests, communication and computer skills, etc. Therefore, the system should minimize technical difficulty and guarantee access by all including impaired people while utilizing decision sciences to improve the quality of decisions.
2. ***System flexibility:*** The system is going to be used in different contexts (i.e. different portion of budget, number of citizens, degree of participation, methods of participation and making decisions, etc.). Therefore the system should be flexible enough to be deployed in many different contexts and should support functionalities such as defining the problem, designing the procedure, developing algorithms for mediation and conflict resolution, choosing communication mechanisms for information and opinion exchanges, etc.
3. ***Algorithms:*** Supporting communication is essential but not sufficient in the system. In order to utilize decision sciences, various algorithms should be considered for constructing and modifying individual/group preferences and risk attitudes, suggesting a series of intermediate solutions for mediation, generating a solution for arbitration, processing various voting mechanisms, etc. Considering the potential size of the problem instance, it is very important that these algorithms are scalable. But scalability is not sufficient. Algorithms should be also investigated whether they are not susceptible to strategic manipulation by allied group of users, protect privacy, and preserve anonymity while providing accountability.
4. ***System scalability and stability:*** The user base of the system could be thousands or easily even more in public decision making processes. Because the user base is large and users' simultaneous access to the system is expected due to the nature of the problem, the system should be stable even when a large number of requests arrive within a very short time period.
5. ***Security:*** The system should support proper and legal authentication and non-repudiation mechanisms while protecting privacy of users. The system should be widely accessible but also should be protected against a malicious user group.
6. ***Social issues:*** Digital divide has been a critical argument against promoting democracy through using ICT. In addition, societies have different degrees of technology diffusion, cultures, legal, and political systems. Often, they are barriers against applying modern decision sciences and ICT to make public decision with increased citizen participation.

Development of the systems supporting the participatory public decision making will be constrained by the development of theory and technology in those and other related areas. However, the degree of applying them will depend on how people perceive them easy to use, useful, and appropriate. And these perceptions will change while they learn and experience and theory and technologies evolve.

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