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Participatory budgets are becoming increasingly popular in many municipalities all around the world. The underlying idea is to allow citizens to participate in the allocation of a municipal budget. Many advantages have been suggested for such experiences including legitimization and more informed and transparent decisions. There are many variants of participatory budgets but in most cases both the design and development are carried out in an informal way. In this paper we propose a participatory budget design methodology based on a multicriteria decision making process.

Key words: group decision support, public budgeting, participatory budgeting, e-participation, technology support, multicriteria decision making, multiattribute value function

1. Introduction

Since the 1960's, an increasing apathy and feeling of alienation among citizens has led to the so-called democratic deficit (Sttefek et al., 2008), which has entailed an increasing interest in promoting participatory processes. These allow citizens to take part in public policy decision making. Participatory budgets (PBs) are emerging as a paradigm for participation, especially at local level, see Sintomer et al. (2008). They constitute an attempt to allow citizens to have a word on the decision of how part of a public budget is spent, mainly in municipalities. It is a budget allocation approach based on dialogue and citizen participation, which diverges from the current predominant representative model. In a sense, PBs are transforming the idea of a representative democracy, in which the citizen's input is considered just at the moment of elections, to move closer to a participatory democracy, based on direct participation and debate.

Early experiences with participatory budgeting took place in Kerala, Lajes, Boa Esperança, Diadema and Vila Velha. However, the most well known, and longest lasting PB experience comes from Porto Alegre, in Brazil (initiated in 1989 and consolidated in 1992), acclaimed for both the efficient and democratic management of urban resources it has made possible. PBs are becoming increasingly popular in many other places, all around the world. Recent reports indicate that more than one hundred municipalities in Europe are implementing these PB processes, see Sintomer et al. (2008). The announcement of the UK government in year 2006 that all municipalities should implement PB experiences by 2012 is symptomatic in this respect, see Röcke (2008). PBs have appeared not only in Europe or South America, but also in other countries including USA, China, India, Indonesia or South Africa.

There are many variants of PBs (see Alfaro et al., 2010). In some cases, they consist, only, of an informative event, so that citizens do not participate directly in decision making. In other cases, PBs entail an intensive participation procedure, using, for instance, voting or negotiation sessions. Generally speaking, they may be seen as a sequence of decision making tasks which are scheduled in various ways leading to different PB processes (Alfaro et al., 2009). However, there is very little guidance on how to design such processes, which are usually adopted in an ad hoc manner. As described in French and Rios Insua (2010), designing participatory processes remains as a key methodological issue in this area.

In this paper we present a participatory budget design methodology described through a multicriteria decision making process. Firstly, we will introduce a PB as group resource allocation problem in which citizens try to agree on a budget in view of multiple criteria, possibly subject to other constraints in addition to the maximum budget limit. Then, we will define a set of alternatives that constitute the various PB schemes, as sequences of basic decisions making tasks. There are some limitations when combining these tasks so we will present the basic logical and logistic constraints that, from our point of view, should satisfy any PB process. Then, we will describe the main objectives to be pursued in a PB process and the attributes that allow us to evaluate them. Furthermore, we will construct a value function to evaluate all feasible PB schemes and we illustrate them in two examples. We end with some conclusions.

2. Participatory budgets

Suppose that a group of n persons has to decide how to spend a budget b. There is a set of q projects, $X = \{a_1, \ldots, a_q\}$. Project a_i has an estimated cost c_i, and is evaluated by the j-th individual with respect to m_j criteria, with values x^j_{ik}, $k = 1, \ldots, m_j$. For simplicity, we assume that we have a sufficiently precise estimate of each project cost and features. We represent this information through a table in which each position associated with a pair composed by project a_i and the j-th individual has a score vector $(x^j_{i1}, \ldots, x^j_{im_j})$, for all $i = 1, \ldots, q$ and $j = 1, \ldots, n$:

		Participant				
Project	Cost	1	$\ldots$	j	$\ldots$	n
a_1	c_1	$(x^1_{11}, \ldots, x^1_{1m_1})$	$\ldots$	$(x^j_{11}, \ldots, x^j_{1m_j})$	$\ldots$	$(x^n_{11}, \ldots, x^n_{1m_n})$
$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$
a_i	c_i	$(x^1_{i1}, \ldots, x^1_{im_1})$	$\ldots$	$(x^j_{i1}, \ldots, x^j_{im_j})$	$\ldots$	$(x^n_{i1}, \ldots, x^n_{im_n})$
$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$
a_q	c_q	$(x^1_{q1}, \ldots, x^j_{qm_1})$	$\ldots$	$(x^j_{q1}, \ldots, x^j_{qm_j})$	$\ldots$	$(x^n_{q1}, \ldots, x^n_{qm_n})$

Assume that the total cost of the projects is greater than b. Otherwise, there would be no discussion. In addition to the budget constraint, there may exist other constraints that restrict the feasible budgets. For example, there could be several projects concerning a new hospital, not being necessary more than one in the final budget. Moreover, there could also be logical constraints, like when there is a project that requires another one to be in the final budget. A feasible budget for the participatory budget problem is a subset of projects, defined by the corresponding subset of indices $F \subseteq I = \{1, 2, \ldots, q\}$, which satisfies the budget constraint,

$$\sum_{i \in F} c_i \leq b,$$

and other possible constraints. The aim of a participatory budget process is to find a feasible budget which, somehow, maximizes group satisfaction.

There are many variants of PB processes (Alfaro et al., 2010) all based on a sequence of common tasks differentiated by how they are combined and scheduled. These tasks are:

- *Participant sampling.* In many processes, participation of all citizens is impossible for logistic or physical reasons. Thus, a group (sample) of citizens is chosen to represent the wider population. This sample could be purposive, random,... depending on the proposed issue or problem.

- *Use of questionnaires.* They aid in focusing on the main issues of interest, revealing what is of most interest to citizens.

- *Preparation of documents.* There are two types of documents: preliminary documents, which contain information about the issue or problem, and final documents, which contain the results from the participatory process. The documents are usually written by representatives and/or experts.

- *Distribution of information.* One of the most important elements in decision-making is having the best possible information about an issue available to participants so as to facilitate decision-making. Similarly, participants should be able to share information they might be able to gather.

- *Problem structuring.* Sometimes problems might not be clearly formulated and participants would spend time structuring the problem, dividing them into parts so as to better apprehend it. In this phase, technicians determine criteria for choosing between proposals, elaborate an initial list of alternatives, together with their associated costs, technical features and constraints among them.

- *Preference modelling.* Participants are sometimes required to express their preferences over consequences or alternatives, usually through pairwise comparisons, goal setting or value functions. These preferences aid participants to find their most preferred alternative.

- *Debate.* Whether regulated or spontaneous, the interchange of ideas is vital for citizen participation. If it does not occur, decisions tend to be unimaginative and poor. Participants can express and discuss their opinions. They also make proposals, possibly supervised by an analyst, to consolidate a final list.

- *Negotiation.* When individuals disagree on their preferred alternative, they may try to deal with the conflict through negotiations, in which participants exchange offers, ideas and arguments so as to try to reach a consensus. Several negotiation methods could be used, such as POSTING or the Balanced Increment Solution, see Rios and Rios Insua, (2010).

- *Arbitration.* Through debate and negotiation, we may find that the parties involved cannot be satisfied and refuse to budge from their positions. To avoid this, some mechanisms include the figure of an arbitrator who makes the final decision, once the opinions and reasoning of the different parties have been presented, see e.g. Raiffa et al. (2002).

- *Voting.* Voting is, many times, used as a last resort, particularly if achieving consensus is not possible. The decision to be applied comes from voting. It may be used, as well, to choose representatives. It can be done following different rules, such as simple majority, approval voting, Borda count, etc, see e.g Nurmi (2010).

Some instances of PB schemes in some European cities include:

- Getafe, scheduled as Distribution of information, Problem Structuring, Debate, Voting, Preparation of documents and Negotiation.

- Morsang-Sur-Orge, scheduled as Debate, Voting and Arbitration.

- Rheinstetten, scheduled as Distribution of information, Use of questionnaires, Voting and Distribution of information.

- Grottammare, scheduled as Debate, Voting, Preparation of documents and Arbitration.

- Emsdetten, scheduled as Participant sampling, Debate, Arbitration and Preparation of documents.

Given the variety of potential PB processes, it seems compelling to develop a participatory budget design methodology, as we do in the following.

3. Participatory budget design problem structuring

3.1. Alternatives

A participatory budgeting process can be described as a finite sequence of tasks, as we have introduced previously which we shall represent through a single character as follows: participant sampling (M), use of questionnaires (Q), preparation of documents (D), distribution of information (I), problem structuring (E), preference modelling (P), debate (F), negotiation (N), arbitration (A) and voting (V). Each sequence of tasks represents an alternative in a participatory budgeting process design problem

$$S = (task_1, task_2, ..., task_n)$$

where

- n, number of tasks included in the process S.
- $task_i$, the task carried out in the i-th place, which will belong to the set $\{M, Q, D, I, E, P, F, N, A, V\}$.

For example, based on the above notation, the participatory budget process that takes place in the city of Córdoba is represented through

$$S = (E, P, V, I, D).$$

3.2. Constraints

As we have mentioned, different schedules of tasks lead to various PB processes. However, there are some logistic and logic constraints that must be satisfied by the task sequence. For instance, some tasks cannot begin or finish a process, some tasks cannot precede others, etc. We provide here a lot of such constraints:

3.2.1. Constraints on the number of tasks. A PB process is a finite sequence of tasks. We should define the minimum and maximum number of tasks that could contain a PB process.

- *Maximum number of tasks.* We need to limit the number of tasks that make up a PB process. A large number of tasks could lead to fatigue among the citizens involved in the process and, consequently, a participation decrease. We consider that nine tasks is a sufficiently high number within a PB process.
- *Minimum number of tasks.* We consider that a PB process must be composed of, at least, two tasks. In addition, one of them should be voting, negotiation, or arbitration, as these are the actual decision making tasks.

3.2.2. The begin-process constraints. Clearly, some tasks should not begin the process such as arbitration, as it is a dispute resolution mechanism involving a third actor, the arbitrator, who makes the final decision, once the opinions and reasoning of the different parties have been presented. Thus, arbitration may not appear as the first task of a process. Furthermore, the use of questionnaires, preference modelling, negotiation and voting tasks should not begin the process.

3.2.3. Constraints on tasks sequence. There are some tasks that cannot be preceded by others. We define the acceptable precedences in Table 1. An X in cell (ij) means that the task of row i can precede the task of column j. For example, the first row of the table means that the task *Participant sampling* could precede all tasks except itself.

	Sampling	**Questionnaires**	**Documents**	**Information**	**Structuring**	**Preferences**	**Debate**	**Negotiation**	**Arbitrating**	**Voting**
Sampling		X	X	X	X	X	X	X	X	X
Questionnaires			X	X	X		X	X	X	X
Documents	X	X	X	X	X	X	X	X	X	X
Information		X	X	X	X	X	X	X	X	X
Structuring	X	X	X	X	X	X	X	X	X	X
Preferences			X	X			X	X	X	X
Debate			X	X	X	X	X	X	X	X
Negotiation			X	X			X	X	X	X
Arbitrating			X	X						
Voting			X	X			X	X	X	X

Table 1 Tasks that can precede to others tasks

A relevant example refers to the negotiation task. In some cases, before starting the negotiation, participants must have communicated their preferences. The inverse sequence is not possible: once the negotiation has been carried out, preference modelling is irrelevant.

3.2.4. Constraints on tasks carried out in parallel. Sometimes two tasks can be carried out in parallel. However, we have only identified two cases where this could occur:

- *Debate and use of questionnaires.* Both tasks can be used to express the participants' opinions about an initial list of proposals. As a consequence, a *Problem structuring* task should appear before them.

- *Use of questionnaires and preference modelling.* Both tasks can be undertaken in parallel to elicit the participants' preferences.

The constraints applied to these pairs must be the same as those applied to them individually. We consider that two tasks carried out simultaneously may appear only once during the process, as they consume many resources.

3.2.5. Constraints on of repetition tasks. For various reasons, such as lack of time or efficiency, some tasks should appear only once. Other tasks could repeat at least once. The following table indicates the maximum number of occurrences of each task within a PB process.

Tasks	**Repetitions**
Participant sampling	1
Use of questionnaires	1
Preparations of documents	5
Distribution of information	2
Problem structuring	2
Preference modelling	1
Debate	2
Negotiation	2
Arbitration	1
Voting	2

Table 2 Maximum number of task occurrences within a PB process

3.2.6. The finish-process constraints. Some tasks cannot appear at the end of the process. However, other tasks should appear at the final stages of the process. This is the case of the arbitration, negotiation and voting tasks.

3.2.7. Constraints on tasks that elicit citizen preferences. Two tasks can be used to obtain information about citizen preferences: *Preference modelling* and *Use of questionnaires*. The inclusion of one of them implies the exclusion of the other task, except if both tasks are carried out in parallel.

3.3. Feasible schemes

We should generate now all PB schemes that satisfy the above constraints. To do it, we must choose how to represent the schemes and constraints. We define a PB scheme as a character sequence where each character belongs to the set {M, D, I, E, Q, F, P, V, N, A}. Furthermore, as we have mentioned, there are two exceptional cases, QF and QP, which could be carried out in parallel. We associated with them two additional characters L and O, respectively. Thus, the characters to generate PB schemes are included in the set: {M, D, I, E, Q, F, P, V, N, A, L, O}. Finally, to represent the constraints we use regular expressions, see Friedl (1997) for more details. Thus, a character sequence that does not match any of these regular expressions constitutes a feasible scheme. In Table 3 we present regular expressions that represents some of the constraints.

Constraint	Regular expression
R1	[MQFIEPDNVAOL]{2,}
R2	[ˆQPNAVLO][MQFIEPDNAVLO]*
R3	[ˆAVPNEQOL]*E([QFO]E)?[DIPFQOL]*[VNA]+[FIPDNVAOL]*
R4	[ˆLO]*ELE[ˆLO]*(N|A|V)[ˆLO]*
R5	[ˆQ]*Q?[ˆQ]*

Table 3 Some constraints as a regular expressions

For example, the R1 constraint means that a sequence is valid if its length is greater than one and the contained character belong to the set {M,Q,F,I,E,P,D,N,V,A,O,L}. R2 indicates that the first character of the sequence is any character other than Q, P, N, A, V, O, or L and the following characters of the sequence could be repeated zero or more times.

To generate the schemes, we first have to generate the total number of schemes before applying the constraints where the tasks can be repeated and the order of its selection is taken into account. If m denotes the number of tasks of a scheme and n is the number of possible tasks, n^m represents all schemes composed of m tasks, regardless of restrictions. Therefore, to calculate the total number (S_m) of feasible schemes of length m, we shall do

$$S_m = n^m - card(C_m)$$

where C_m is the set of schemes of length m that do not satisfy the constrains that we have described above. For instance, for $m = 3$:

$$S_3 = 12^3 - card(C_3) = 12^3 - 1610 = 118$$

The last step to obtain the final set of feasible schemes, is to include all schemes resulting from tasks grouped in two, three, ... up until nine.

$$\sum_{m=2}^{9} \left[n^m - card(C_m) \right]$$

Table 4 provides the number of feasible schemes

Number of tasks	Number of possible schemes	Number of feasible schemes
2	12^2	11
3	12^3	118
4	12^4	742
5	12^5	3,329
6	12^6	11,643
7	12^7	33,331
8	12^8	81,213
9	12^9	175,770
Total		306,157

Table 4 Feasible PB process

To conclude this section, we present some of PB processes generated:

- S_2 ={FN, FA, FV, MN, MV, DN, DV, IN, IV, EN, EV} represents the feasible schemes with two tasks.
- S'_3 ={FVA, FPN, MFN, MND, DNI, DLA, IQN, IVA, EVN, EVA} is a subset of feasible schemes with three tasks, which include the schemes of the cities of Morsang-Sur-Orge (FVA) and Salford (DLA)
- S'_4 ={FPND, FVDA, FOFV, MFAD, MQVA, DFAD, DMPA, INQA, IQVI, EVNA} are some of the feasible schemes with four tasks, which include the schemes of the cities of Rheinstetten (IQVI), Grottammare (FVDA) and Emsdetten (MFAD).
- S'_5 ={FPFVD, FVNQV, MFNQA, MFOAD, DVNIA, DMPNA, IPVNV, IVDQA, EPNVD, EPVID} is a sample of feasible schemes with five tasks which include the scheme of the city of Córdoba (EPVID).
- S'_6 ={FPFNDA, FEIVAI, MVDFAD, MEFOAI, DPNFNV, DQVFVI, INVADI, IEFVDN, EFOVFN, ELEDNI} is a subset of feasible schemes with six tasks which include these of Getafe (IEFVDN) and Madrid (ELEDNI).

- S'_7 ={FPFDVIA, FEPIDFN, MQDNVIN, MEIPDVI, DMFQFVA, DEIQFVI, IPNVFAD, IEFPVFN, EFOVIND, EDFNVNI} represents some of the feasible schemes with seven tasks.
- S'_8 ={DIDEFDAD, DMEFOIAD, EDPVINID, EIDQIDVD, FEIDQIAD, FPNFVDAD, INQVFDVI, IDVFVQNI, MEFPIDAI, MQVNVFAI} is a subset of feasible schemes with eight tasks.
- S'_9 ={DVFDVDQAD, DMIENVFVI, ELEIQNFAI, EIDQIDFVD, FDQNINVFA, FEQID-NIVN, IEFEIQNAD, IDEQVFVND, MNVIVDIQA, MEPINVFND} is a sample of feasible schemes with nine tasks.

4. A Value function for participatory budget design

We describe now the preference model adopted in the PB process design.

4.1. Objectives and attributes

We first elaborate a list of objectives to be achieved when citizens are involved in a PB process. An important issue when designing a PB experience is to identify the objectives describing why are we conducting the exercise and what do we hope to achieve, see Bayley and French (2007), Rowe and Frewer (2004) and Rowe and Frewer (2005) or Keeney (1992), for a general discussion on value focused thinking. Rowe and Frewer (2000), Rowe and Frewer (2005), Macintosh and Whyte (2006), Aichholzer et al. (2008) and Aichholzer and Westholm (2009), have proposed several attributes evaluate the effectiveness of a participatory process once it has undertaken. Based on this, we suggest the following objectives, illustrated in Figure 1:

1. *Maximize the relevant information.* A key element of this type of processes is to dispose the best information possible. For this, it is necessary to involve citizens, technicians and authorities to identify complete and relevant information from them. We thus distinguish the following sub-objectives:

(a) *Maximize the relevant information from participants.* An effective process requires the elicitation of all relevant information from actives citizen. Rowe and Frewer (2005) identify two structural aspects of engagement mechanisms that are liable to affect the likelihood of maximizing such relevant information: the presence or absence of a facilitator and the response mode available, in particular, whether it is "open" or "closed".

(b) *Maximize the information from technicians and authorities.* Both authorities and technicians responsible for initiating engagement processes invariably assume that any information provided by them is relevant, comprehensive, and appropriate for citizens understanding. Therefore, it is necessary to elicit all relevant information from them.

(c) *Maximize information exchange.* Through information exchange the stakeholders involved in the PB process can share their opinions and knowledge.

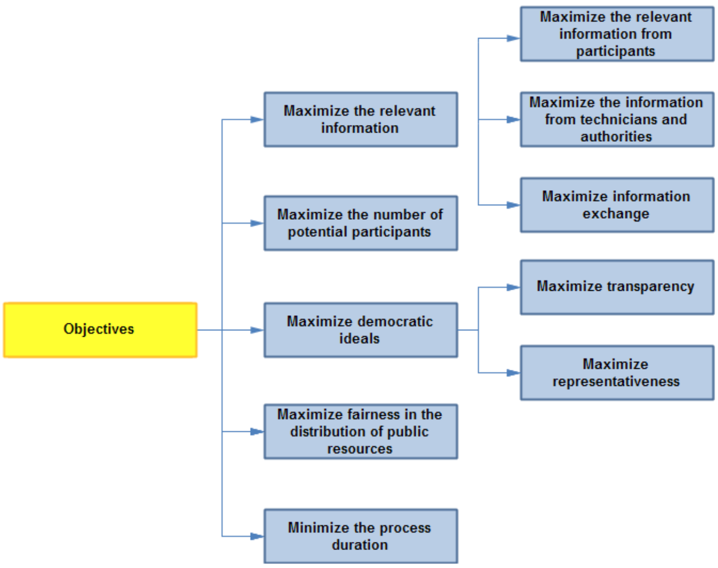

Figure 1 Objectives of participatory budget processes.

2. *Maximize the number of potential participants.* Involving a diverse group of participants in decision making processes lead to obtain a greater number of opinions and more creative ideas.

3. *Maximize democratic ideals.* There is a range of democratic issues that need to be considered when a participatory process is designed. We therefore, consider the following sub-objectives:

(a) *Maximize transparency.* A key issue is building trust in the authorities conducting the PB process and in the PB process itself.

(b) *Maximize representativeness.* Sometimes it is impossible to involve all citizens in the PB process. In this case, we must ensure that all relevant viewpoints are represented in the PB process.

4. *Maximize fairness in the distribution of public resources.* Public resources must be distributed more equitably and fairly without discriminating the minority groups.

5. *Minimize the process duration.* A key issue in any process that requires the citizens involvement is its duration. It is clear that a process requiring excessive activity of citizens will lead to fatigue and, consequently, a low participation rate.

For some of these objectives, we may identify natural scales

- Response mode available. The measure scale is: “None”, “Closed”,“Open”, which we identify with the values 0, 1, 2, respectively.
- Presence of a facilitator. The possible values are: “No”, “Yes”, which we identify with the values 0,1, respectively .
- Level of engagement. The measure scale is: “None”,“Communication”, “Consult” and “Participation” corresponding to the values 0, 1, 2 and 3, respectively.
- Process duration. Is the sum of the duration of all tasks in PB process. We can measure it in days where the duration of each task is show in Table 5.

Tasks	**Duration (in days)**
Participant sampling	1
Use of questionnaires	3
Preparations of documents	3
Distribution of information	5
Problem structuring	5
Preference modelling	1
Debate	4
Negotiation	2
Arbitration	1
Voting	1

Table 5 Duration of tasks

For the rest of attributes, we have used Likert scales, see Trochim (2006) for details. The attributes that we consider are shown in Table 6 together with its measurement scale:

Objectives	Attributes	Scale
Max. information from participants	Response mode available	[0-2]
Max. information from technicians and authorities	Presence of a facilitator	[0-1]
Max. information exchange	Medium of information transfer	[1-5]
Max. number of potential participants	Number of potential participants	[1-5]
Max. transparency	Availability of information	[1-5]
Max. representativeness	Pluralism	[1-5]
Max. fairness in distribution of resources	Level of engagement	[0-3]

Table 6 Attributes to evaluate de the objectives

Table 7 proposes an evaluation of each of the tasks in terms of their success against the objectives.

Number	Objectives	Attributes	Sampling	Questionnaires	Documents	Information	Structuring	Preferences	Debate	Negotiation	Arbitration	Voting
1	Max. info. participants	Response mode available	0	2	0	2	0	1	2	2	0	1
2	Max. info. techn. and auth.	Presence of a facilitator	0	0	0	1	0	1	1	1	0	0
3	Max. info. exchange	Medium of info. transfer	1	3	3	5	1	3	5	5	1	1
4	Max. number of participants	Number of participants	1	1	2	5	1	4	5	5	1	5
5	Max. transparency	Availability of information	1	1	2	5	3	4	4	4	1	5
6	Max. representativeness	Pluralism	3	2	1	4	1	4	4	4	1	4
7	Max. fairness in dist. of resources	Level of engagement	0	2	1	3	1	2	2	3	2	3

Table 7 Evaluation of tasks in PB processes

4.2. Value function

We define now a value function to evaluate the feasible schemes to obtain the PB process that maximize the preferences of the process designer.We assume an additive value function, see Von Winterfeldt and Edwards (1986), which also takes into account the number of repetitions of the same task. Specifically, a PB process $S(t_1, t_2, \ldots, t_n)$ will be evaluated through

$$v(S) = \sum_{i=1}^{n} \rho_i \left[\sum_{j=1}^{r-1} w_j v_j(t_i) \right] + w_r v_r(d(S))$$

where

- $\rho_i = \rho^{k-1}$ if it is the k-th occurrence of task t_i in the process.
- r is the number of objectives, 8 in our case, in the same order as we have introduced them.
- w_j is the weight of the j-th objective.

- $v_j(t_i)$ is the effectiveness of task t_i with respect to the j-th objective.
- $d(S)$ is the process duration.
- $v_r(d(S))$ is the evaluation of the duration of the process.

Once we have constructed v, we have to solve the problem

$$\max v(S)$$
$$\text{s.t. } S \in R$$

where R is the set of feasible PB processes. Note that the set R could be further constrained by cost or other resource availability considerations.

5. Examples

To illustrate how to use our methodology, we should consider two examples.

5.1. Example 1

In the first case we only consider the achievement of five goals, with the following weights:

- 0.05 to maximize the number of potential participants.
- 0.10 to maximize transparency.
- 0.12 to maximize representativeness.
- 0.23 to maximize fairness in the distribution of public resources.
- 0.50 to minimize process duration.

We assume that $\rho = 0.8$. We present the results according to the number of tasks:

- *Schemes composed of two tasks*: The maximum value obtained is 14.08 with the scheme MV (participant sampling and voting).
- *Schemes composed of three tasks*: The maximum value obtained is 11.40 for the scheme MPV (participant sampling, preference modelling and voting). Other schemes with three tasks are carried out in the cities of: Morsang-Sur-Orge (debate, voting and arbitration) with a value of 7.99 and Salford (preparation of documents, use of questionnaires in parallel with debate and arbitration) with a value of 5.86.

- *Schemes composed of four tasks*: The maximum value obtained is 10.32 for the schemes MPVA (participant sampling, preference modelling, voting and arbitrating) and IPVN (distribution of information, preference modelling, voting and negotiation). Other schemes with four tasks are carried out in the cities of: Rheinstetten (distribution of information, use of questionnaires, voting and distribution of information) with a value of 7.95, Grottammare (debate, voting, preparation of documents and arbitration) with a value of 7.39 and Emsdetten (participant sampling, debate, arbitration and preparation of documents) with a value of 5.98.
- *Schemes composed of five tasks*: The maximum value obtained is 10.77 for the scheme IPNVN (distribution of information, preference modelling, negotiation, voting and negotiation). Other schemes with five tasks are carried out in the city of: Córdoba (problem structuring, preference modelling, voting, distribution of information and preparation of documents) with a value of 8.23.
- *Schemes composed of six tasks*: The maximum value obtained is 11.95 for the scheme FPNVIV (debate, preference modelling, negotiation, voting, distribution of information and voting) and its 3 feasible permutations. Other schemes with six tasks are carried out in the cities of: Getafe (distribution of information, problem structuring, debate, voting, preparation of documents and negotiation) with a value of 9.72 and Madrid (problem structuring, use of questionnaires in parallel with debate, problem structuring, preparation of documents, negotiation and distribution of information) with a value of 8.12.
- *Schemes composed of seven tasks*: The maximum value obtained is 13.24 for the scheme FPNVIVN (debate, preference modelling, negotiation, voting, distribution of information, voting and negotiation) and its feasible permutation.
- *Schemes composed of eight tasks*: The maximum value obtained is 14.47 for the scheme FPNVIVNI (debate, preference modelling, negotiation, voting, distribution of information, voting, negotiation and distribution of information) and its 8 feasible permutations.
- *Schemes composed of nine tasks*: The maximum value obtained is 15.58 for the scheme IPFNIVFVN (distribution of information, preference modelling, debate, negotiation, distribution of information, voting, debate, voting and negotiation) and its 16 feasible permutations.

5.2. Example 2

In the second example we consider the following weights:

- 0.05 to maximize the relevant information from the participants.
- 0.05 to maximize the relevant information from the technicians and authorities.
- 0.05 to maximize the information exchange.
- 0.20 to maximize the number of potential participants.
- 0.20 to maximize transparency.
- 0.30 to maximize representativeness.
- 0.10 to maximize fairness in the distribution of public resources.
- 0.05 to minimize process duration.

We assume $\rho = 0.8$. The optimal schemes in this case are:

- *Schemes composed of two tasks*: the maximum value obtained is 8.21 for the scheme IN (distribution of information and negotiation).

- *Schemes composed of three tasks*: the maximum value obtained is 11.58 for the scheme INV (distribution of information, negotiation and voting) and its feasible permutation. Other schemes with three tasks are carried out in the cities of: Morsang-Sur-Orge with a value of 8.57 and Salford with a value of 5.22.

- *Schemes composed of four tasks*: the maximum value obtained is 15.13 for the scheme FNVI (debate, negotiation, voting and distribution of information) and its 5 feasible permutations. Other schemes with four tasks are carried out in the cities of: Rheinstetten with a value of 12.33, Grottammare with a value of 9.80 and Emsdetten with a value of 7.55.

- *Schemes composed of five tasks*: the maximum value obtained is 18.37 for the schemes FPNVI (debate, preference modelling, negotiation, voting and distribution of information) and its 9 feasible permutations. Other scheme with five tasks is carried out in the city of Córdoba with a value of 13.55.

- *Schemes composed of six tasks*: the maximum value is 21.49 for the scheme FPNIVI (debate, preference modelling, negotiation, distribution of information, voting and distribution of information) and its 13 feasible permutations. Other schemes with six tasks are carried out in the cities of: Getafe with a value of 17.66 and Madrid with a value of 14.19.

- *Schemes composed of seven tasks*: the maximum value obtained is 24.48 for the scheme FPNVINI (debate, preference modelling, negotiation, voting, distribution of information, negotiation and distribution of information) and its 14 feasible permutations.
- *Schemes composed of eight tasks*: the maximum value obtained is 27.38 for the scheme FPFNVINI (debate, preference modelling, debate, negotiation, voting, distribution of information, negotiation and distribution of information) and its 14 feasible permutations.
- *Schemes composed of nine tasks*: the maximum value is 30.25 for the scheme IPFNIVFVN (distribution of information, preference modelling, debate, negotiation, distribution of information, voting, debate, voting and negotiation) and its 16 feasible permutations.

6. Conclusions

Due to increasing demand for citizen participation in public decision processes, some municipalities are implementing participatory budgets, allowing for citizen participation in local investment decisions. The level of involvement of participants can be decided upon by the authorities conducting the PB process.

Despite PB experiences have increased over the last years, in most of them, their design and implementation are carried out in an informal way. The advent of e-democracy and e-participation increases the need for effective design processes since the systems have to be built before use and there is much less scope for tailoring the processes to meet public needs as the debate progresses. For this reason, in this paper we have proposed a participatory budgets design methodology based on a multicriteria decision process.

We consider in order that a PB process achieves a high degree of citizen satisfaction, the first issue should be to determine its objectives. We have identified them after a review of the literature (Keeney 1992; Bayley and French 2007; Rowe and Frewer 2004; Rowe and Frewer 2005). We have illustrated the use of this methodology with two examples obtaining a list of optimal PB processes. Furthermore, we have noted that the resulting PB processes improve the PB processes carried out in European cities.

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References

Aichholzer, G., Allhutter, D., Freschi, A.C., Lippa, B., Macintosh, A., Moss, G., Westholm, H. 2008. eParticipation Evaluation and Impact. *DEMO-Net Project Deliverable* No.13.3

Aichholzer, G., Westholm, H. 2009. Evaluating eParticipation Projects: Practical Examples and Outline of an Evaluation Framework. *European Journal of ePractice*,7,27-44.

Alfaro, C., Gómez, J., and Rios, J. 2010. From participatory to e-Participatory Budgets. Rios Insua and French (eds), *e-Democracy: A Group Decision and Negotiation Approach*, Springer

Alfaro, C., Gómez, J., Lavín, J.M. 2009. A configurable architecture for e-Participation support. *3rd International Conference on Methodologies, Technologies and Tools enabling e-Government*. Vigo.

Bayley, C. and French, S. 2007. Designing a Participatory Process for Stakeholder Involvement in a Societal Decision.*Group Decision and Negotiation*, 17, 179-193.

French, S., Ríos Insua, D. 2010. e-Democracy: A Group Decision and Negotiation-Oriented Overview. Rios Insua and French (eds), *e-Democracy: A Group Decision and Negotiation Approach*, Springer.

Friedl, J.E.F. 1997. *Mastering Regular Expressions.* Sebastopol, CA: 0'Reilly Media.

Keeney, R. and Raiffa, H. 1976. *Decisions with Multiple objectives: Preferences and Value Tradeoffs.* Wiley.

Keeney, R. 1992.*Value-focused Thinking: a Path to Creative Decisionmaking.*Harvard University Press, Cambridge, MA.

Macintosh, A. and Whyte, A. 2006. Evaluating how eparticipation changes local democracy, e-Government Workshop, London. Retrieved September 28, 2008, http://www.iseing.org/egov/eGOV06.

Numri, H. 2010. Voting Theory. Rios Insua and French (eds), *e-Democracy: A Group Decision and Negotiation Approach*, Springer

Raiffa, H.,Richardson, J. and Metcalfe, D. 2002. *Negotiation Analisis: The Science and Art of Collaborative Decision Making*. Cambridge, MA, Harvard University Press.

Ríos, J., Ríos Insua, D. 2010. Balanced increment and concession methods for negotiation support, *RACSAM*, 104, 41-56. DOI:10.5052/RACSAM.2010.05.

Röcke, A. 2008. Participatory budgeting in the UK: from the "grassroots" to the national agenda. The Participatory Budgeting Unit

Rowe, G., and L. Frewer. 2000. Public participation methods: a framework for evaluation.*Science, Technology and Human Values.* 25,3–29.

Rowe, G., and L. J. Frewer. 2004. Evaluating public-participation exercises: a research agenda. *Science, Technology and Human Values.* 29, 512-556.

Rowe, G., and L. Frewer. 2005. A typology of public engagement mechanisms. *Science, Technology and Human Values.* 30, 251–290.

Sintomer, Y., Herzberg, C., Röcke, A. 2008. Participatory budgeting in Europe: potentials and challenges. Int. Jour. Ur. Reg. Research, 32, 164-178.

Sttefek, J., Kissling, C., Nanz, P. 2008. Civil Society Participation in European and Global Governance: A Cure for the Democratic Deficit? Basingstoke: Palgrave Macmillan.

Trochim, W. M. 2006. Likert Scaling. Research Methods Knowledge Base, 2nd Edition. http://www.socialresearchmethods.net/kb/scallik.php. Retrieved April 30.

Winterfeldt, D. and Edwards W. 1986. Decision Analysis and Behavioral Research. Cambridge: Cambridge University Press.604.