Selecting the Right Software for Supporting Participatory Budgeting in Local Government – Reviewing Suitable Solutions

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Abstract. Participatory Budgeting (PB) empowers the constituents to decide on how to spend a part of the public money. The citizens create proposals, which are then (if they are within the given rules of the PB) voted on by the public. It is believed that PBs strengthen democracy and increase the efficiency of public spending.

Information and communication technology (ICT) can support these PB initiatives. There are several software solutions available for implementing a PB. However, picking the right solution is far from an easy task as the solutions are as diverse as the needs and possible requirements of administrations. This paper scrutinizes different solutions in aiming to provide support for aspiring municipalities in selecting the right PB software.

The following work sheds light on the differences between the available software solutions. First, we shortly describe the applications and then lay out the tested capabilities of the software. Afterward, we show the fulfillment level of these capabilities and present an excel tool for making individual, informed decisions. The paper is concluded with a description of the tool selection process in two Finnish municipalities.

Keywords: Participatory Budgeting, Software Analysis, Review, ICT.

1   Introduction

Participatory budgeting (PB) puts a part of the cities' budget in the responsibility of the constituents. This idea of PB as a democratic process which gives people real power over real money is crossing continents with various experiments and experiences from different parts of the world [1–3]. Since its origins in 1989 in Porto Alegre, Brazil, PB has spread to over 7,000 cities worldwide, and interest continues to grow [4]. In PB, the citizens can craft proposals for allocating the budget, and these proposals are later

voted on by the whole community, with the proposals receiving the most votes getting implemented [5]. While a commonly accepted definition for a PB is missing, Sintomer et al. [2] defined five criteria for a PB:

1. A PB is in its core concerned with questions on how a limited budget should be used.
2. The city level with some power over administration and resources has to be involved.
3. PB is not a one-time event but repeated over the years.
4. PB includes a form of public deliberation. A simple survey without a public forum is not deemed sufficient
5. Accountability is a vital part of PB. Accepted projects get implemented, and the public must be informed regarding implementation progress.

In detail, a PB process could look like the following [4]: At first, citizens are informed on the rules of the upcoming PB and how to participate. In the following step, they are asked to create proposals on how and what to spend the money. If a given proposal passes a first check, where the city staff validates the eligibility criteria (meaning it conforms to the set PB rules and falls into the city's jurisdiction), it moves to the presentation stage, where all proposals are shown on a website. After the "request for proposal" stage closes, the city performs a final and very detailed feasibility check. The costs are checked carefully, as potential conflicts with other stakeholders. As soon as the final list of eligible and realistic proposals are crafted, these proposals are allowed to the public discussion and voting phase. After the voting is concluded and the constituents pick the best ideas, the realization follows, and the public is informed on the implementation progress.

The process depicted in **Fig. 1** is just an example of a PB process. As a PB has to fit into the cultural and jurisdictional environment in which it is implemented, the process has to be adapted as well. Universally, however, it is believed that PB can strengthen democracy and improve state performance [6]. The former through citizens participation in open and public debates, which increases their understanding of public affairs. The latter through constraining the municipal government and their prerogatives and the increased opportunities for citizens to be engaged in public policy debates [7, 8].
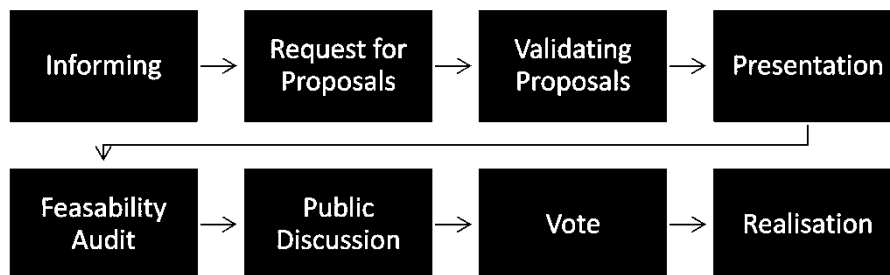
Fig. 1. Stereotypical PB Process [9]

These processes can be strongly supported using information and communication technology (ICT) [10, 11]. As PB is a rising phenomenon worldwide, more applications for the electronic support of these participatory processes were developed. However, these software solutions differ widely in their functionality. This diversity can make the software selection for an administration difficult.

Moreover, the prior literature is limited in investigating PB processes from an ICT perspective. In 2011, IBM gathered examples for public engagement initiatives in a technical report [12]. While it also contains tool descriptions, it mainly outlines when to use which kind of engagement tactic. In 2016, the developer of AppCivist (a software solution that is also analyzed in this paper) examines a sample of currently available solutions for civic participation [13]. We fill the research and knowledge gap by focusing on the software solutions supporting the PB process. This study aims to provide a review of suitable software solutions for PB.

Consequently, we pose two research questions: (1) what the main features of suitable software solutions for PB are and (2) how those solutions can support successful implementation of the PB process in local governments. Research questions are answered by conducting a subsequent analysis and a review of software solutions. To illustrate the process of finding suitable solutions for PB, empirical case examples from Finland are provided and discussed. In a previous report [9], two of the authors presented a feature repository for PB applications. This feature repository is the foundation for the subsequent analysis of PB software presented here.

In total, we analyzed eleven PB solutions. The result is captured in an Excel-Sheet and available online [14]. In addition, the paper includes two empirical case examples of the ICT solutions in PB processes in Finnish municipalities. The first one, the city of Riihimäki, utilized the Decidim platform in their PB process. The second city, Lahti, utilized their existing ICT platforms not explicitly designed for PB, Maptionnaire, and Webropol. These empirical cases illustrate different approaches to ICT solutions in PB, showing that the PB process can benefit from ICT tools and that finding an ICT solution is a versatile issue. In both of these cases, empirical data is collected through semi-structured thematic interviews (8 interviews in Riihimäki, 17 interviews in Lahti) and surveys targeted for members of organization and citizens (in Riihimäki n=75 in citizen survey and n=30 respondents from members of organization citizens, in Lahti n=243 and n=39). The empirical data is analyzed with methods of content analysis.

The rest of this paper is structured as follows. The following section is concerned with a description of the analyzed PB software and the feature list the software is checked for. Section three presents the results of the analysis, followed by the Finnish case studies. Afterward, the research is concluded, and we give an outlook on future activities.

2 Analyzed Software and Features

2.1 Analyzed PB Software

The following section gives an overview of the analyzed PB software. It presents, in a short description, the different target groups and pricing models of the software. As not

all software is also featured in academic literature, the list of analyzed tools is based on an internet search for software that supports public decision-making processes.

DemocracyOS.[1] Developed by Argentinian-based development team "democracia en red". They provide several democracy-related applications, e.g., PB, public consultation, crowd law-making, and goals tracking. All software is available open-source, though they provide an installation and customization service

OpenDCN.[2] Developed by Milano University (Italy). Integrated platform for PB, events, petitioning, and other e-democracy related use cases. Software is available ppen-source. Not regularly updated (last update from November 2018), parts of the description are just available in Italian.

AppCivist.[3] PB-suite by the University of California. Even though stated as open-source, commercial use is not permitted and requires permission. The tool is available as Software as a Service (SaaS[4]).

Placespeak.[5] Location-based consultation software. Developed by a private company in Vancouver (Canada). Provides the possibility to give feedback to local developments. Not a full-grown PB tool. Commercial, SaaS tool.

Polis.[6] Not a PB tool in the classical sense. Implements a system for gathering opinions based on the resonance of comments in a discussion. Developed by a nonprofit organization in Seattle, open-source.

Your Priorities.[7] A PB software that was made by the Islandic nonprofit "Citizens Foundation". Open-source, can be self-hosted or purchased as a SaaS service.

Loomio.[8] Loomio is a decision-making platform. It is targeted not only at governments but also at NGOs and private companies. The software is open-source, though a paid SaaS is offered.

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[1] shttps://democraciaos.org/en/
[2] http://www.opendcn.org
[3] https://pb.appcivist.org/
[4] In a Software as a Service (SaaS) delivery model, the hosting of the application is provided by the Vendor
[5] https://www.placespeak.co
[6] https://pol.is/home
[7] https://citizens.is/
[8] https://www.loomio.com

Consider.it.[9] The application is not a PB, but a vote polling platform. The users can share an idea, and others can agree or disagree using a slider. U.S.-based; it is open source. SaaS and customization are available.

Consul.[10] Citizen participation software. It supports PB, collaborative legislation, debating, proposals and voting. It is developed by a European nonprofit organization. It is open-source; certified companies offer installation and development.

Decidim.[11] The Decidim software is a digital democracy platform that facilitates PB, citizen consultations, digital assemblies, communication, and strategic planning. It is an extensive software solution; PB is just one part of it. The software is open-source and managed by an NGO in Barcelona (Spain).

Citizenlab.[12] E-democracy platform. Offers a range of features like polls, survey, proposals, information and also PB. Source code is available but under a proprietary license. Offers SaaS. Developed by a private company in Brussels (Belgium).

Maptionnaire.[13] Not a PB-Tool, but developed for community engagement. Provides polling, surveys, and a form of gamified decision making. Developed by a for-profit company in Helsinki (Finland)

2.2 Checked Features

The following section presents the features that are the basis for the analysis of the software. These features are structured along the process shown in **Fig. 1**. Please note that these steps are not strictly subsequent but sometimes overlap.

Informing. The first phase captures how much information on PB is given on a software's website. It shall enable aspiring administration to see relevant use cases for a given application.

Table 1. Analyzed Features for Process Item "Informing"

Item	Description
Participation process	Provide information on how to participate in the PB process using the presented software.
Goals for PB	Display the desired outcomes for a PB implementation

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[9] https://consider.it/
[10] https://consulproject.org
[11] https://decidim.org
[12] https://www.citizenlab.co
[13] https://maptionnaire.com

	on the software's web-page
Success Stories	The web pages give examples for success stories of other municipalities

Request for Proposal. In this stage, the citizens are asked to hand in proposals to improve their city. The analyzed capabilities are, thus, related to the upload of proposals on the PBs website and the registration requirements.

Table 2. Analyzed Features for Process Item "Request for Proposals"

Item	Description
Mandatory registration	The software supports a mandatory registration before the handing in of proposals
Registration requirements	The software supports additional, formal registration requirements, e.g., issued code, citizen registration number
Predefined Categories	To further structure the submitted proposals, they can be categorized (e.g., in "playground" or "landscaping").
Upload a File	The PB website implements a file storage. It is possible to upload a picture or a document smaller than 5 MB
Cost Estimation	Citizens can include a cost estimation with their proposals
Locational data	The position of the proposal can be chosen and displayed on a map

Validating Proposals. Not every idea proposed by citizens is eligible. While the specific design of the proposal check is often highly customized, the chosen software has to provide the required assessment capabilities.

Table 3. Analyzed Features for Process Item "Validating Proposals"

Item	Description
Status Management	Every submitted proposal is associated with a status representing the current state of the processing (e.g., "waiting for validation", "ready for voting")
Pre-Moderation	The administration checks if a proposal fits into the given rules of the PB. It can also decline a proposal.
Administrative Feedback	The administration can write a short statement to the proposal. This statement is essential if a proposal is getting declined.
Notification	Submitters are updated regarding comments and status updates of their proposals by e-mail.

Presentation. As soon as a proposal passes the first check by the municipality, it is displayed on the PB's website. This stage comprises the capabilities for a user-friendly presentation of the data.

Table 4. Analyzed Features for Process Item "Presentation"

Item	Description
Proposal List	The list of published proposals is shown on the web page.
Search Capability	The web page has a function to search the published list of proposals.
List filtering	A user can filter the list for the predefined categories (e.g., implementation status, rating).
Export functionality	The list of published proposals can be downloaded (e.g., in an Excel or PowerPoint file).
Rating	Users can publicly rate a proposal (e.g., through "likes"). These ratings are independent of the binding voting process.
Comments in the reviewing process	Users of the platform can comment on each other's submitted and published proposals.

Feasibility Audit & Public Discussion. The administration does a final feasibility check as soon as the "request for proposal" stage is closed. It also allows a discussion board for a general debate not only on specific proposals but on the PB in general. The latter, thus, is not bound to a specific timeline but can coexist throughout the whole PB timeline.

Table 5. Analyzed Features for Process Item "Feasibility Audit & Public Discussion"

Item	Description
Estimate costs	The list of published proposals is shown on the web page.
Debate Tool	Users of the platform can comment on each other's submitted and published proposals

Voting. With the list of eligible proposals finalized, the constituents now vote on the proposals they like best.

Table 6. Analyzed Features for Process Item "Voting"

Item	Description
Voting Implementation	The PB software provides a voting capability.
Voting Codes	The voter eligibility is captured through the issue of a unique code.

Realization. The realization stage accompanies the implementation of the voted proposals.

Table 7. Analyzed Features for Process Item "Realization"

Item	Description
Media Involvement	The PB website informs citizens on the progress of the implementation of accepted proposals.

Not all of these features are equally important regarding building a PB – while it might be possible to build a PB without filtering capabilities for the list of proposals, supporting a voting process is mandatory. [9] further categorizes these elements into "mandatory", "recommended", and "optional".

3 Analysis of the PB Software and Case Examples

3.1 Assessment Methodology

The evaluation builds upon the software's documentation. In cases where the documentation was insufficient, additional resources like reference implementations or blog posts were taken into account. The assessment is translated into discrete "yes" or "no" values for the prevalence of capabilities. While one could argue that, for some of the assessed capabilities, a further breakdown of the assessment into gradual values enables the encoding of more information, the authors decided for a binary encoding to limit the influence of subjective perceiving and to circumvent possible scaling issues.

Possible dependencies between capability items were not considered. As these tools have to fit into an existing IT landscape, the possible dependency resolutions are manifold. For example, even though we can consider a voting capability mandatory, which heavily influences the rest of the PB software, a municipality might have such a system already in place that it wants to use. It, thus, is able to resolve the dependencies without the need for an individual capability. The selection of what is essential and what is not is, therefore, up to the user.

3.2 The Assessment Results

scenarios.

Fig. 2 presents the assessment of the software using the capabilities presented in section 2.2. The specialized tools Maptionnaire and Polis fulfill the smallest amount of capabilities. This lack of functionality is explained by the fact that both do not focus on the PB use case but on gathering public opinions. The other tool that does not originate from a PB background is Consider.it. However, this application covers a surprising amount of PB capabilities.

The most extensive software is Decidim. It is shortly followed by Citizenlab and Placespeak. These software solutions cover a wide range of PB scenarios and are highly versatile in their possible application scenarios.

Fig. 2. Assessment of the Software Solutions

3.3 Choosing the Right Tool

Choosing the right software tool is far from a trivial task. Not all functionalities have the same relevance for an administration. Also, the needs and capabilities of citizens vary. To assist municipalities in selecting the right software, the authors developed a tool to help them make an informed choice. It incorporates a rating based on the multi-

attribute decision theory and implements a weighted sum model to calculate the best-fitted software [15].

The user provides weights to the importance of each capability item, and the tool calculates the PB software that best fits the needs in a given situation. A weight can be any number between 0 and 100 (thus, it is also possible to use percentage values). The software then evaluates the PB-tools by multiplying the capability rating with the weights (thus, summing up the weights for the capabilities that the software provides). At the last step, the summed up values are normalized to a percentage value, and a rank is created. The program is based on Microsoft Excel and is available online [14].

To use the tool, the user should provide a weight for each capability item and state if it must be fulfilled or not. The range of the weights is up to the user. The weights shall represent the individual assessment of the importance of each item in comparison to the others. They can be assigned any number above zero. A weight of zero constitutes that a capability is not considered in the ranking of the software.

Fig. 3. Excerpt of Online Tool for PB Assessment (Top Half): Weight and Must-Criteria [14]

Item	Description	Weight	Must-Criteria	DemocracyOS	OpenDCN	AppCivist
Participation Process	Provide information on how to participate in the PB-process using the presented software.	0	No	Yes	Yes	Yes
Goals for PB	Display the desired outcomes for a PB implementation on the web-page.	0	No	Yes	Yes	Yes
Success Stories	The web-pages give examples for success stories of other municipalities.	1	No	No	No	No
Mandatory Registration	The software supports a mandatory registration before the handing in of proposals.	3	No	Yes	Yes	Yes
Registration Requirements	The software supports additional, formal registration requirements, e.g., issued code, citizen registration number.	0	Yes	No	Yes	Yes
Predefined Categories	To further structure the submitted proposals, they can be categorized (e.g., in "playground" or "landscaping").	2	No	Yes	Yes	No
Upload a File	The PB-website implements an object storage. It is possible to upload a picture smaller than 5 MB.	2	No	No	Yes	Yes

While some capabilities are nice to have and optional, others are mandatory. These mandatory categories can be filtered using the column "Must-Criteria". If a capability is set to be a "Must-Criteria", all items that do not fulfill this criterion are not further considered in the ranking. If such filtering occurs, the cell fills red.

An example of the ranking is shown in **Fig. 4**. As – in this fictive example – DemocracyOS does not fulfill a Must-Criteria; it is not further considered in the comparison of the available tools.

Fig. 4. Excerpt of Online Tool for PB Assessment (Bottom Half):
Calculated Ranking of the Tools Based on the Provided Weights and Must-Criteria [14]

Debate Tool	Users of the platform can comment not only on each submitted and published proposal, but also in a general forum for discussion on a broader perspective (not only related to proposals).	3	Yes	Yes	Yes	Yes
Voting Implementation	The PB software provides a voting capability.	5	Yes	Yes	Yes	Yes
Voting Codes	The voter eligibility is captured through the issue of a unique code.	3	No	No	No	No
Media involvement	The PB-website informs citizens on the progress of the implementation of accepted proposals.	2	No	Yes	Yes	No
				0%	84%	71%
				☆ 7	☆ 5	☆ 6

While the fulfillment level of the selected capabilities is a valid criterion for the nomination of a tool, one should not be overly concerned with the prevalence of additional capabilities. Simply selecting the tool with the most extensive set of capabilities available might create a bulky overhead regarding implementation and maintenance.

Rather than looking for a tool that fits as many capabilities as possible, it is likely better to look for the tool that best fits one's individual needs. Furthermore, besides the hard factors of the fulfillment level, soft factors should also influence the tool selection process.

Depending on the size and utilization of the local IT department, a government might choose a SaaS tool or run the applications themselves. Municipalities from smaller countries might face obstacles in the availability of language packs. Moreover, as PB initiatives happen in a highly local environment and are often bound to local laws, selecting a tool from a vendor who has experience with the local cultural and jurisdictional environment might also prove helpful, especially if there are already existing relationships between the vendor and the municipality, as the next section will show.

4   Case Examples From Finland

Participatory budgeting has sparked broad interest in Finland, especially in local government, ever since 2012 (e.g., [6]). Finnish municipalities are active in promoting PB as a method of strengthening citizen participation. Municipalities are not obligated to run PB, but it is mentioned as a suggestion of one method of participation in the Finnish Local Government Act. Both of the Finnish empirical case examples have run their first rounds of city-level PBs. The data was collected after the first round of PB in Lahti in November-December 2020 and after a second round of PB in Riihimäki in February-March 2021. In addition, in Lahti, a first citizen survey was conducted before the first round of PB in September-October 2019. As our case examples illustrate, each pilot process is as unique as are the IT tools used in them.

A citizen survey conducted in 2019 in the city of Lahti – the first EmPaci PB pilot in Finland - showed an interest in PB and especially taking part by using electronic services. Lahti ran their first city-level PB process in 2020 and used existing ICT platforms for the process. Ideas were gathered using Maptionnaire – a map-based platform previously mainly used in city planning. Voting was conducted using Webropol. There was a strong political will to try out PB in Lahti, but the same will was not shared in the city organization. Also, Lahti was simultaneously making difficult cutback management decisions which affected the resources for PB. There were no financial resources available for investing in a separate participatory ICT platform. Also, the financial resources to be allocated through PB were taken from the operational resources of the department responsible for coordinating PB. This created difficulties in the adequacy of resources for service operations and affected the interest and attitudes to try out PB.

The Maptionnaire platform provided a possibility to put ones' idea on the map and then clarify it with text and by adding documents. It was also used to gather background information on those leaving ideas such as age, gender, or household income level. This type of data is important for process evaluation purposes, even though collecting it can raise questions among citizens. The end-use and necessity need to be well communicated to avoid misunderstandings that can hinder participation. A downside of this platform was that the ideas were not publicly on show during the process. This resulted in

overlapping ideas that needed to be processed by the city personnel in the pre-checking phase and took up citizens' time, possibly affecting their satisfaction with the process.

In the citizen survey conducted after the PB, respondents were relatively satisfied with the use of the tools. The tools were seen as easy to use. Feedback from the city PB personnel was also positive. The map-based solution received positive responses. The main criticism was addressed to the fact that ideas were not on public display. Only those ideas that passed the pre-check phase and moved on to voting were published. This limited the transparency of the process, leaving citizens unaware of the result of their submitted idea. Also, using two different platforms received criticism. While both platforms were relatively easy to use, this created unnecessary hindrances for the agility and transparency of the process. It is also essential to recognize that different citizen groups find using ICT tools convenient or difficult. As an example, the majority of the citizens involved in PB, in this case, were working-aged women.

The second Finnish PB pilot, the city of Riihimäki, had begun their PB in 2019. They had decided to invest in a separate platform: A Decidim based solution, a rather popular choice among Finnish benchmark municipalities of different sizes such as Tuusula and the capital city Helsinki. It was also used in the second run in 2020, although some changes were made to the first model after feedback received from citizens and staff on the first round. Similar to Lahti, also local politicians in Riihimäki supported the implementation of PB. However, the starting point for PB in Riihimäki was different than in Lahti. As the city council decided to implement PB, they allocated financial resources of 1 million euros for PB into a fund that was established specifically for PB and to be used in multiple years to come. Simultaneously, they decided to invest in a new, customized PB software - Decidim.

This platform offers necessary functionalities and can be easily altered to suit individual needs but with extra cost for tailoring. The Riihimäki platform hosted the entire process from leaving ideas to voting, providing a transparent process as citizens had access to each other's ideas. To leave an idea or vote, one had to register on the platform, but data about the individuals were not gathered. This meant that process evaluation could not be conducted at the same level as, for example, in the Lahti case. This is also something municipalities should take into consideration when choosing and using a platform. One of the changes the city made after the first process was to include a Like-function in their process. For an idea to make it through to the final voting, it had to gather at least 10 Likes on the platform. This was done to activate citizens and encourage them to visit between leaving ideas and voting.

Citizen feedback on the use of the platform was divided as nearly 50% of respondents found leaving their ideas poor or satisfactory in the citizen survey. The newly introduced Like-system also raised questions as the process was somewhat unclear to many respondents. All in all, here, like in Lahti, the most active participants were working-aged women. The respondents of the surveys were concerned that the IT platform does not reach all citizen groups – for instance, the elderly were seen to be left out.

City personnel, in turn, pointed out some technical difficulties they had encountered in the platform and hoped for improvements on it to make it easier to use/clearer and make voting more see-through for future processes. Also, the platform did not support the collection of user data. This created difficulties in contacting citizens that submitted

their idea. Many of the ideas were drafts that needed clarifications in order to be evaluated by the city personnel.

In both of the case examples, PB was run during the outbreak of the COVID-19 pandemic. The role of ICT solutions became more evident than it was initially expected. Face-to-face meetings and campaigns were canceled, and PB was promoted mainly by using social media. Especially in Riihimäki, the second round of PB laid heavily on the Decidim platform. Due to the change in staff but also to the impact of the COVID-19 pandemic on city personnel, PB was caught in the middle. However, Lahti chose a different approach and focused on still offering something positive for citizens during the volatile times in the form of PB even though their initial plans would have focused more on live meetings, not a separate platform. Thus, in Lahti, the PB process was considered a success with 713 ideas and 3896 votes. While in Riihimäki, interviewees regarded the PB process "a technical implementation" of PB without the live meetings and face-to-face promotions of the first round of PB. The turnout of the second round of PB in Riihimäki was fewer ideas and votes than the first round of PB.

Based on the findings in the analysis of the empirical data, it can be said that different ICT models and tools can work even if a municipality cannot choose an ideal tool due to, for example, financial, availability, or timeline constraints. Some tools take more financial commitment, others are more labor-intensive, but each PB is different, as are the municipalities running them and the citizens taking part. It is worth keeping in mind that PB should be an ever-evolving process by nature. Bold trials and continuous development have a place also in finding the right tools. Another noteworthy point is that the process of PB cannot merely rest on the ICT tool. As the Riihimäki case illustrates, PB cannot solely be run with the ICT platform. It needs human and financial resources. While an ICT platform is designed for PB, there might still appear during the PB such needs that the platform cannot meet, which might create hindrances for PB process and limit the successful turnout of PB. ICT tools can support the process at its best, but it cannot be the whole process.

5 Conclusion and Outlook

The presented paper compared various available software solutions for supporting participatory budgeting. A PB process can take various shapes, thus differ the requirements of a PB software tool. The analyzed data and evaluation framework can help cities that aspire to implement a PB to pick the right tool that best fits their individual PB process.

However, as seen by the case examples, there is more to selecting software than a mere list of features. Equally important are "soft" factors like previous usage experience, the will and knowledge (or not) to adapt and develop open-source software, or the willingness to pay a commercial vendor. Choosing a more extensive software with more supported features might, on the one hand, provide enough reserve for future extensions. On the other hand, this extensive range of functions also brings a higher level of complexity. Thus, the tool's strategy should fit into the strategy of the city.

We believe that the proposed evaluation methodology helps municipalities select the right software for their specific needs. The presented case examples already brought

insights into the selection processes of PB software. However, there is room for further studies on how cities select PB software and what they might need to make better-informed decisions.

Acknowledgments

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