BudgetMap: Issue-Driven Navigation for a Government Budget

Nam Wook Kim
Harvard SEAS
Cambridge, MA, USA
namwkim@seas.harvard.edu

Chang Won Lee
Computer Science, KAIST
Daejeon, Korea
chiyah@kaist.ac.kr

Jonghyuk Jung
Industrial Design, KAIST
Daejeon, Republic of Korea
heretor92@kaist.ac.kr

Eun-Young Ko
Mathematical Sciences, KAIST
Daejeon, Republic of Korea
key44@kaist.ac.kr

Juho Kim
MIT CSAIL
Cambridge, MA, USA
juhokim@mit.edu

Jihee Kim
Business and Technology
Management, KAIST
Daejeon, Korea
jiheekim@kaist.ac.kr

Abstract

We present BudgetMap, an interactive tool for navigating budgets of government programs through a lens of social issues of public interests. Our novel issue-driven approach can complement the traditional budget classification system used by government organizations by addressing time-evolving public interests. BudgetMap elicits the public to tag government programs with social issues by providing active and passive tagging methods. BudgetMap then facilitates visual exploration of the tagged budget metadata. Through a lab study, we show how the design of BudgetMap helps users develop awareness and understanding of budgetary issues while identifying issue-budget links. We also share lessons learned from a preliminary live deployment.

Author Keywords

Budget; interactive visualization; crowdsourcing.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

A government budget is taxpayers' payment for services yet to be implemented. It is also considered as the single most important policy document of a

Related Work

There are some recent projects that introduce interactive tools designed to increase public awareness and solicit participation.

ManyBills [2] combines visualization and machine learning techniques to improve the readability and understandability of legislative documents.

BudgetChallenge (www.budgetchallenge.org) by next10 is a collective prioritization tool that asks citizens to make budgetary decisions given the fixed budget.

Moreover, systems such as **ManyEyes** [6] and **TagATune** [3] are similar to our work in that the systems help people categorize and navigate information by providing tagging interfaces and visualizing the complex data with tags.

government [1]. Accordingly, the ability to evaluate how a government spends taxpayers' money is fundamental to a democracy [2].

Despite recent efforts in opening government data, developing tools for taxpayers to make sense of extensive and multi-faceted budget data remains an open challenge. Even though the budget proposals and plans are available online in many countries, the existing resources suffer from two main drawbacks: 1) they fail to reduce the complexity of the budget in their way of delivery, and 2) their static format cannot accurately reflect public interests that constantly evolve over time. In addition, while taxpayers are capable of understanding complex issues and making informed decisions, government organizations lack suitable tools for leveraging the wisdom of crowds [7,8].

To address these challenges, we present BudgetMap, an issue-driven navigation interface for the budgets of government programs. It allows navigating a government budget through a lens of social issues, which reflect public interests in a dynamic and timely manner. To collect the necessary linkage information between social issues and budget programs, we explore human computation methods that elicit user contributions via active and passive tagging methods. We evaluate BudgetMap with a laboratory study and a preliminary live deployment.

Issue-Driven Budget Navigation

To justify the needs for using "social issues" to navigate government budget programs, which we call the "issue-driven approach", we borrow a case of a recent tragic accident in Korea and its impact on the budget. On April 16th, 2014, the Sewol ferry sank and 284 people died and 20 people went missing[1]. After the disaster, the public has raised concerns about the government's safety management and the budgets allocated to it. As the government programs for public safety were spread out across various budget categories in the current classification system, taxpayers had trouble understanding how their money was spent on public safety. In response, the government introduced a new budget plan by introducing a new budget accounting layer for the public safety. However, it is unsustainable for a government to create a new accounting scheme whenever there is a new issue to be addressed. Thus, we believe that the public should be at the center of the necessary changes in making the budget classification system dynamically reflect the public's evolving interests.

We hypothesize that dynamic issue-driven classification by the public will have the following advantages over the existing classification system. First, our classification reflects public interests and uses the language of the general public, therefore making the budget more accessible for navigation. Second, our classification can meet the timely needs of the public because social issues by nature reflect the current status of a society. Third, budget classification using issues built by taxpayers can serve as constructive feedback for government officials in the next budgeting cycle or improving the current system; by engaging in government activities, taxpayers will become better informed [8]. However, we do not expect our issue-driven classification to replace the existing system, but instead supplement it while improving public understanding and awareness.
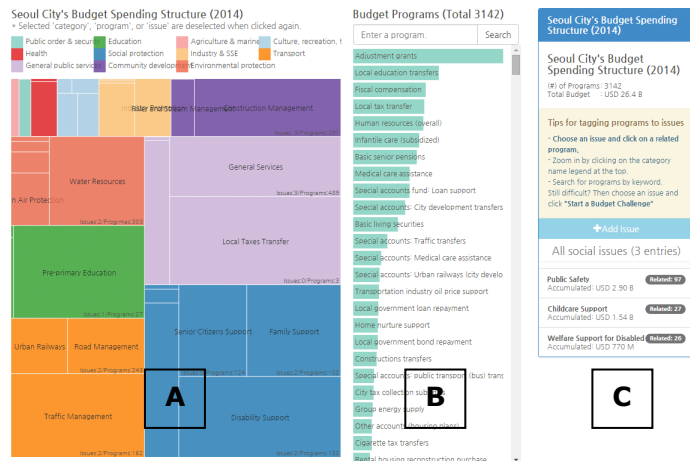
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[1] http://www.nbcnews.com/storyline/south-korea-ferry-disaster

Figure 1(a). Overview of the BudgetMap interface
A: Budget category information of Seoul city
B: A list of programs sorted by the budget size
C: A list of social issues

Figure 1(b). Issue-driven navigation: When the user selects an issue, relevant budgets and programs are highlighted. On the middle panel, the matching programs are shown at the top.

BudgetMap Design and Implementation

Figure 1 shows a screenshot of BudgetMap being deployed on the web. The interface is divided into three panels displaying budget categories (A: treemap), a list of programs (B: bar chart), and a list of social issues (C: list group). The left panel displays an overview of the entire budget space, and the selected budget category is used for filtering programs in the bar chart. If no category is selected, all programs are displayed. On the middle panel, programs are sorted according to their budget size and can be searched by keywords. On the right panel, a summary of the selected program and a list of related issues are shown. Likewise, if no program is selected, all issues are displayed.

Data Collection and Processing
The current version of BudgetMap relies on two data sources (budgets and programs) managed by the City of Seoul (opengov.seoul.go.kr and cleanplus.seoul.go.kr). A program is a unit of operating budget and refers to a set of activities that meets specific

policy objectives of the government. We synthesize them into a single coherent data model where each entity has a program name, its allocated budget, and two-level categories to which the program belongs. A social issue is a form of tag that may connect to budgets from multiple programs.

Active tagging involves the user deliberately tagging a budget with an issue. We provide two ways to do this task: the user selects a program of interest and then adds an issue to the program (Figure 1(a): light-blue 'Add Issue' button on the right panel), or the user selects an existing issue first and adds a program to the issue by clicking on the program. In the former, the issue is added to the global issue list without any program attached if no program is selected. To assist with browsing and tagging, programs can be searched with keywords, or filtered by a budget category.
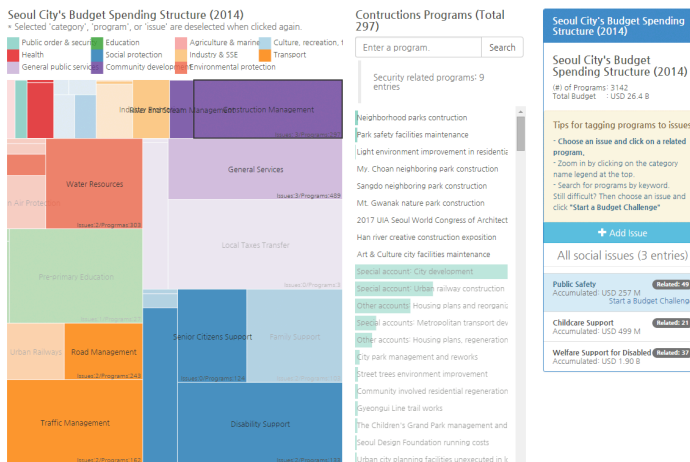
Passive tagging solicits lightweight and structured contributions from less active users, who may not deliberately search for programs and add links (Figure 2). This task is activated when a user selects an issue and clicks the 'Start a Budget Challenge' button. A random program is displayed and a user is asked to decide whether the program is related to the selected issue by choosing one of three options: 'Related', 'Unrelated', and 'Unclear'. This method keeps showing a new task upon completing the previous one. All users' collective contributions (i.e., the total budget of related programs) as well as individual contributions are displayed, much like scores in a gamified environment. With passive tagging, the user can quickly add tags for the current issue without separately navigating the budget structure.
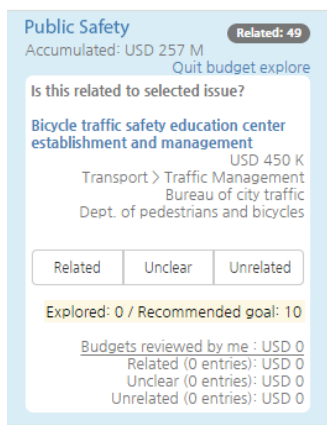
Figure 2. Passive tagging: a user is presented with a randomly chosen program and asked to determine the relationship with the selected issue.

Navigation and Voting

Once budget programs are tagged with issues, a user can navigate the budget space through a specific issue. All the budget categories and programs related to the selected issue are highlighted, while other elements are grayed out (Figure 1(b)). A user can also evaluate the tag quality by indicating if the tag is 'related', 'not related', or 'unclear.' The voting interface appears if there is an existing link between an issue and a program. In our simple quality control method, when an issue is selected, corresponding programs are highlighted only when the number of votes for 'related' is greater than that of 'not related.' More sophisticated methods can be applied with more tag quality data.

Evaluation

For evaluation, we ran a lab study with active and passive tagging tasks in BudgetMap. Our goal was to see if our issue-driven and crowdsourced classification has advantages over the existing classification system. Specifically, our hypotheses were:

H1. Participants will create issues that span multiple categories in the traditional budget classification system and that reflect trending public interests.
H2. Participants will accurately identify issue-program links in active and passive tagging tasks.
H3. Participants' awareness and interests on government budget policies will increase after active and passive tagging activities using BudgetMap.

Interfaces and Procedures

Nineteen participants were recruited from a behavioral study participant pool at a university (5 female, 14 male, age mean=21.79, stdev=2.74). In our lab study, each participant was first asked to come up with any social issues that they would like to know how much

budget is allocated to. Then they were asked to use three different budget navigation interfaces: Interface A provided a simple treemap visualization interface of the existing budget classification used by the city's government. Interface B was BudgetMap with only the active tagging enabled. Interface C was BudgetMap with only the passive tagging enabled.

Each issue was paired with one of the three interfaces. The issue-interface pairs and their orders were counterbalanced across participants so that the results of any issue (or any interface) do not get influenced by the interaction with a specific interface (or issue) or by the temporal order that the issue (or the interface) is explored. A participant had 7 minutes for each `issue-interface' pair to gather information and estimate the total budget related to the assigned issue, using the given interface.

Budget Estimation Tasks

The study used a within-subject design: each participant used all three interfaces in a session. A participant was asked to estimate the total budget related to three social issues using different interfaces each time: public safety, childcare support, and welfare support for the disabled. In Interface A, where detailed budget information in program units was missing, we provided web links to the Seoul's open data web portal (opengov.seoul.go.kr) so that participants could search through the open data without our interface support. While our ultimate goal was finding a crowdsourced answer to estimate the budget size of an issue, the task in this user study was designed to give a participant a concrete goal or incentive to actively use the interfaces.

Results

H1: *Issues of interests are dynamic and span multiple categories*. In our pre-task question, 19 participants created 82 issues: 30 of those spanned multiple government-defined categories and 10 of those were identified as trending social issues, evaluated by a data analyst of the Seoul's budget data in our research team. For instance, the budgets related to 'public safety,' 'support for low-income families,' and 'support for minorities' spanned over multiple categories and `Sewol ferry accident' and '(recently reformed) welfare support for the elderly' are some of the examples of the highly debated current issues. We suggest that this qualitatively supports H1.

H2: *Accurate issue-program tagging.* To evaluate issue-program links that participants had created, we acquired an expert solution to how much budget went into each of the three issues. The evaluation result of the tagged links according to this reference solution is given in the left sidebar.

As people's definition of a social issue can vary widely, we expect the 'Related' links created in BudgetMap to reflect a union of various definitions of an issue. We first observe that participants are more likely to find a correct `Unrelated' issue-program link. Next, we see that the accuracy for 'weakly related' links is over 70% except for 'public safety'. In case of the issue 'public safety', we posit that its definition significantly varies across people compared to the issues of 'childcare support' and 'welfare support for the disabled'. This is one of BudgetMap's current limitations, which we hope to be able resolve by outlining the definition of an issue through multiple stages and ensuring multiple reviews by crowd.

H3: *Increased awareness and interests on a government budget.* In our post-task survey, we asked whether the given interface increases the participant's interest on the budget policies related to the given issue and whether the given interface helped a participant to better understand the budget policies related to the given issue. The survey results support H3, summarized in the left sidebar on the next page.

Preliminary Live Deployment: Although our lab study provides some evidence for our hypotheses on the issue-driven classification and navigation, the crowdsourcing nature of collecting issue-program links calls for a large-scale deployment. We had a preliminary live deployment of BudgetMap on September 15th, 2014, using a version that supported both active and passive tagging methods. In the first five days since our deployment, 3,441 users visited the website, 11,459 actions were logged (clicks, search, tagging, and voting), and 697 issue-program links were tagged as `related' or `unrelated' in both tagging methods. The correctly tagged links account for 37%~65% of the total tags depending on the issue. The low rate of correct crowdsourced tags is partly due to the lack of active participation from visitors, which implies that quality control has a lot of room for improvement.

Discussion and Future Work

Many website visitors appreciated the ability to view and navigate the city's policy programs and their budgets. This shows that presenting budget data in a publicly accessible way can provide value to the public. However, we also discovered challenges in guiding the public to actively engage in tagging tasks while making meaningful contributions. Overcoming these challenges

Results: Increased Interest and Awareness on the Government Budget

Q. Did the given interface increase your interest on the relevant budget policies? (1-7 Likert) The average scores were 4.89, 4.42, and 3.16 for Interface B, C, and A, respectively ($p<0.005$ in K-W test).

Q. Did the given interface help you better understand the relevant budget policies? (1-7 Likert) The average scores were 5.37, 4.32, and 2.84 for Interface B, C, and A, respectively ($p<0.001$ in K-W test).

Participants reported that Interface B & C had increased their interest and awareness on a government budget more than Interface A with $p<0.05$ for Tukey HSD. Interface B scored higher than C while the result of Tukey HSD was not significant. There was no issue effect and no interaction effect between interfaces and issues tested by 2-way ANOVA.

This result shows that BudgetMap's tagging interfaces had positive on participants' interest and awareness on the government budget.

will be crucial for BudgetMap to have broader social implications.

Need for quality control in the wild
There were instances of taxpayers' subjective and diverse interpretation of issues, which is a common problem shared by other tagging systems. To this end, effective quality control is needed. A lesson we learned was that there is a trade-off between lowering the bar for participation and ensuring quality responses. We will explore various mechanisms to help users avoid unintentional mistakes and to fight spamming behavior.

Difficulty of soliciting taxpayers for participation
Another challenge is to guide the public to participate more actively in the tagging tasks. While taxpayers' reactions to tagging were overall positive, casual users on the web have not participated in the tagging as actively as we initially expected. It may be due to the inherent complexity and difficulty of budgetary information. We plan to redesign the tagging workflow with more explicit incentives in the next version.

The open government movement brings new challenges for both the government and the public in making the best use of open government data and presenting it in a readily accessible way. BudgetMap is a step toward addressing this challenge by combining visualization, crowdsourcing, and social tagging in one place. We believe the ideas presented in BudgetMap can play a significant role in making the government data more accessible, raising public awareness on budgetary issues, and encouraging public participation.

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