Towards Designing a Map-Based Data Visualization Application to Enhance Collaboration through Awareness among Different Experts in Vitality

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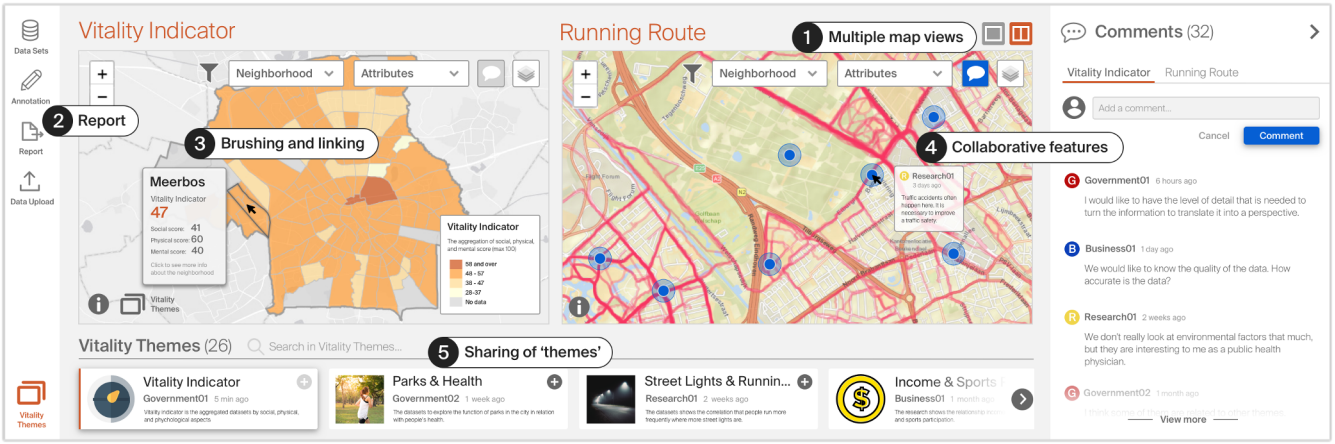

Figure 1: Proposed design of a map-based vitality data visualization application to enhance collaboration through awareness targeting various experts. 1. Split map panels; 2. Create report (e.g., in PDF format); 3. Click to highlight data and show detailed and related data; 4. Add annotations and make comments; 5. Combined datasets considered as 'vitality themes.'

Abstract

Visualizations have been used for solving real-world problems in a variety of contexts. Therefore, it is considered that empirical studies to understand visualizations in each specific context are necessary. We conducted a study to understand users' search behavior and requirements on a visualization utilized by various domain experts who work on improving vitality, which is considered a major societal issue today. A mixed-methods study involving online surveys, open-ended tasks, and semi-structured interviews was conducted with three experts each from the fields of government, business, and research (N=9). The results of our study show that a combination of multiple datasets potentially supports achieving goals for various users in the context of vitality. The study also found the collaborative use of visualizations among domain experts. Based on these findings, we propose a preliminary design of a collaborative map-based data visualization application for the field of vitality. For this application, we hypothesize awareness to be a key factor to enhance various users' engagement and collaboration.

Keywords: Information Visualization, Map, Collaboration, Awareness, Vitality.

Index Terms: [Human-centered computing]: Visualization—Empirical studies in visualization

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1 Introduction

With the advantage of providing cognitive support to understand large amounts of information [1], visualizations are widely used to solve real-world problems in many different contexts [2]. As real-world problems tend to be complex with various data sources and people involved [2], empirical studies are needed to understand visualization in each context [3]. In this paper, first, we present our study to investigate search behavior and requirements among various domain experts on a map-based visualization in the field of vitality. Consequently, based on the results of the study, we propose the design of a visualization application with vitality-related data.

Scholars have been discussing the ambiguity of vitality as it contains a variety of aspects such as psychological, physical, subjective, and social ones [4]. Our previous study [5] also found the multidimensionality of vitality and vitality data. To visualize such multidimensional vitality data for diverse users, we adopted the format of map. Our previous study [5] found its advantage for our context-specific purpose, which is also in line with the concept of Public Participation Geographic Information Systems [6].

Therefore, we used a map-based data visualization, which allows users to holistically analyze vitality data from a geographical region and several perspectives, for a study to understand the search behavior and requirements of them on such visualization. The study used a mix-methods design involving online surveys, open-ended tasks, and semi-structured interviews. The key findings of the study were: a) the potential of collaborative features and b) the requirement of combined data to present on such visualization for understanding vitality data in-depth. Based on the findings from this study, we propose a collaborative map-based data visualization application design for which we consider awareness as an important factor for supporting collaboration.

2 Study Design and Analysis

Three experts each from the fields of government, business, and research (N=9) participated in the mixed-methods study (6 male and 3 female participants whose ages ranged from 25 to 54 years). Their work experience ranged from 6 to 30 years. As their positions are related to vitality, such as sports policy adviser, all participants were familiar with the concept of vitality. The study consisted of three steps: 1) online surveys to ask participants' profiles including professions, 2) open-ended tasks for the participants to freely explore a map-based data visualization, which contained a variety of spatial vitality data (e.g., sports participation rate by neighborhood), and which allowed them to interact with the visualization (e.g., overlay map layers), and 3) semi-structured interviews, which were video recorded to analyze their search behavior and requirements on the visualization in-depth. The interview recordings were transcribed and analyzed using a deductive coding approach [7]. Among several codes created by the first author, we present a subset – which particularly provides insights for designing a visualization application in the context of vitality – in the following.

3 Results

In this section, we present the coding results of "features," "collaboration," and "approach." These results provided us some first insights for the next phase of our research to design a collaborative map-based data visualization application for vitality experts.

Features. There were several suggestions from the participants, such as "multiple map views," "creation of reports," and "filtering," One participant from the government pointed out the importance of the aggregated datasets (e.g., mental, physical, and social aspects) to communicate vitality data.
Collaboration. Six out of 9 participants mentioned features related to collaboration including the annotation. Especially, two participants from the research domain shared their stories about their collaborative work such as, *"We conducted concept mapping sessions with both professionals and residents together."*
Approach. We mainly found top-down and bottom-up like approaches. Some participants first explored the whole view of the visualization and then went into details. Contrary, the other participants dived straight into interacting with the visualization.

4 Collaborative Map-based Data Visualization Application Design

In this section, we discuss important features for a collaborative map-based data visualization in the context of vitality based on the findings discussed in the previous section.

1) Multiple map views. Although the maps already allow to overlay several datasets for spatial analysis [8], we consider this feature to further support users' in-depth visual analysis by allowing them to compare maps.
2) Report. It was noticed through the study that domain experts generally prefer exporting or printing the results of their visual analysis to share with others such as project partners.
3) Brushing and linking. In our study, we found the participants liked to select the area of their interests (neighborhood) to inspect detailed information about it in another view.
4) Collaborative features. A visualization of vitality data should support this through features such as annotation, discussion, and sharing of content such as "report" (see above).
5) Sharing of 'themes.' We got insights by the study that vitality often cannot be presented by a single parameter. Thus, the combination of multiple datasets grouped together as a 'vitality theme' may communicate vitality data more effectively.

Adopting the above features, we propose the design of a collaborative map-based data visualization application shown in Figure 1. We hypothesize that awareness is an important factor to enhance collaboration among diverse users as it provides ideas of available tools and an indication of the presence of people [9]. Among several different types of awareness discussed in the field of Computer-Supported Cooperative Work [10], our focus is awareness information [11] ("data" in particular). We consider data awareness as a factor to communicate the various aspects of vitality data. We particularly consider a way that allows diverse domain experts to group multiple vitality datasets into a 'vitality theme' as essential communicating the perspectives of vitality data.

5 Conclusion and Future Work

In this paper, we presented the results of a study investigating the search behavior and requirements on a map-based visualization among domain experts in the field of vitality. Based on the findings, we proposed the design of the collaborative map-based data visualization application. Currently, mainly text sharing features have been considered but additional ways for map-related and multidimensional collaboration such as the "sharing of themes" could be examined as well. At present, we consider this sharing of themes (combination of the datasets created by users) as a key feature to realize awareness. We also hypothesize that the awareness enhances users' engagement and collaboration. Further studies are necessary to investigate how this feature can support collaboration, analysis, and also the insight generation process. Likewise, future studies would benefit from additional experts to obtain additional perspectives.

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