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ORIGINAL ARTICLE

Studying Requirements from Multiple Actors on Vitality Data Platform through the Lens of Socio-technical Systems

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Abstract: Despite the great potential of data platforms to help solve societal issues, the actual usage of data platforms is still limited due to the lack of consideration of socio-technical aspects. To understand requirements from multiple actors on a vitality data platform, semi-structured interviews were conducted with three groups of actors: representatives of organizations involved in vitality (N=8), government officials (N=10), and citizens (N=20). From these interviews, we got an understanding of the multidimensionality of vitality data and got an insight into the different expectations on the vitality data platform among those actors. Citizens strive to gain general information such as advice for healthy living. On the other hand, the two other groups of participants generally expect low-level data. Our findings suggest that data has to be presented in multiple formats and social discussion features are required to connect those different actors on data platforms.

Keywords: *Vitality data, User study, Socio-technical system*

1. INTRODUCTION

Open data aims to support and engage multiple parties, such as civil society organizations, businesses, policy-makers, and citizens in order to innovate products, improve services, and solve societal issues [24, 33]. However, this great potential of open data has not been fully realized yet due to the lack of consideration of the diverse users of open data platforms [19, 20, 24, 37]. Scholars have been discussing the necessity of a socio-technical approach for open data research that considers the technology and social system together (i.e., interactions from multiple actors on a data platform) [19, 20, 24, 37].

The complexity of interactions on open data has been discussed by scholars such as Meijer et al. [17]. These scholars highlight the importance of a context-specific approach by providing two case studies: open data with public transportation and policing, which specify the context of open data to capture the complex interactions caused by societal dynamics and various values of multiple actors.

In our research, we focus on the domain of vitality. The concept of vitality has been appealing to researchers in the field of (public) health [27] and physical activity [10] as well as health professionals [25]. Many scholars address the broad sense of vitality, such as "personal mastery", "energy", "aliveness", and "enthusiasm". Furthermore, vitality is a highly subjective concept, which relates to one's feelings and emotions, and also consists of phenomenological aspects [10, 22, 25]. Due to these diverse aspects, defining vitality data remains challenging.

Therefore, this paper, extending our previous study [31], focuses on exploring multi-actor requirements on a data platform and discusses challenges with understanding the diverse perspectives of vitality data. Consequently, this study contributes to providing insights for designing a data platform shared by multiple actors in the domain of vitality.

To help understand requirements posed on such platforms, semi-structured interviews with three groups of stakeholders – that is representatives of organizations involved in vitality (N=8), government officials (N=10), and citizens (N=20) – were conducted to address the following overarching research question: What are the requirements for a data-driven platform shared by multiple actors in the case of vitality data? To answer this research question, we explored three sub-questions in these interviews: (i) What kind of data is related to vitality? (ii) What are the actors' goals and objectives? (iii) Which data is necessary to support actors in achieving their own and mutual goals?

Our goal is to design and develop a data platform, referred to as the Data System (DS) as part of the Vitality Living Lab (VLL) project. The Vitality Living Lab (VLL) project is a partnership project among businesses, civil society organizations, and research and knowledge institutes. The VLL project aims to establish a data

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ecosystem for innovation in sports and vitality in a region in the Netherlands. For instance, the societal issue of physical inactivity today has been attracting initiatives to foster active lifestyles and vitality [12]. Given this trend, the VLL project strives to realize public-private cooperation through the DS. Our research is to support this data-driven innovation by designing and developing the DS, which shares vitality data among various users.

2. VITALITY

2.1 Concept of Vitality

The concept of vitality is derived from the term of vitalism [27]. Vitalism describes the concept that living organisms have a life force to compose their organic processes. Although this concept has been disappearing with the advancement of science during the 19th-century [27], the concept of vitalism is rediscovered and elaborated in many fields today such as humanities and social sciences [21].

2.2 Subjectivity and Multi-dimensionality of Vitality

Guérin [10] defines vitality as a "psychological sense of aliveness, enthusiasm, or energy". This psychological sense is also related to our bodies as several scholars discuss the phenomenological quality of vitality [10, 25, 27]. Therefore, it is considered that physical activity is one of the factors influencing vitality. On the other hand, there are studies focused on the emotional aspects of vitality such as Penninx et al. [22]. Penninx et al. [22] found that positive emotions contributed to reducing several health risks among older disabled women. Furthermore, several scholars indicate that demographics and social contexts influence our vitality [22, 25, 28].

Given those factors, we see the subjectivity and multi-dimensionality of vitality, which is perceived differently by individuals. Therefore, this paper investigates the meaning of vitality from the perspective of various actors to define the relevancy of vitality data for the specific context of each actor.

2.3 Perspectives of Vitality from Different Domains

The research of vitality has different angles depending on the domain. The study by Penninx et al. [22] in the area of medicine and public health examines the relationship between emotional vitality and adverse health outcomes. As seen in the phenomenological characteristic of vitality, there is a relation between physical activity and both the energy level (defined as vitality in their paper) and fatigue indicated by a study in Sports Science [18]. Researches from Geoscience such as the one from Marquet and Miralles-Guasch [14], have been looking into the relationship between built environments and human activities. In Industrial Design, there is an increase of interest in vitality research with various data-enabled applications for interventions based on user's behavioral data [23]. As such, the different interests and usages of the term across diverse domains provide further challenges in identifying what vitality encompasses.

3. RELATED STUDIES

3.1 Socio-technical Aspects of Data Platform

Socio-technical systems take both technical factors and social factors (such as those from humans and organizations) into consideration [1]. Several scholars discussed the importance of a socio-technical approach in open data considering the perspectives of multiple actors [5, 6, 9, 35, 38]. Zuiderwijk and Janssen [38] conducted mixed-methods research and gathered qualitative and quantitative data to identify barriers to the open data process. Their study found social (e.g., people, policies, procedures, and regulations) and technical (e.g., hardware, infrastructures, network, and software) barriers at each step of the open data process, which are defined as creating, publishing, finding, using and discussing by the authors. These authors also found that one of the social barriers in publishing data is the unclarity of how the published data is reused by and what are the requirements from many types of users [38]. An empirical study by Gregory [9] focused on data search in open research data from the perspective of socio-technical systems. Their empirical evidence showed dynamic interests and practices for data search among diverse researchers, which are influenced by social factors such as data seekers communities [9]. To understand diverse users' requirements on open data platforms, a user study by Ojo et al. [19] found that poor data quality, low relevancy of data, the lack of accessibility, and poor usability reduces the overall quality of data platforms.

Like the aforementioned studies, we also consider the importance of socio-technical aspects for our study of open data platforms. Particularly, our study follows the idea by Meijer et al. [17], that is the importance of a context-specific approach to studying open data to capture complex multi-actor interactions. Our research focuses on the data platforms to curate vitality data used by multiple actors, such as government officials, entrepreneurs, researchers, civil society organizations, and citizens.

3.2 Context-specific Data Platforms

Based on the necessity of a context-specific approach to understanding complex interactions [17] and a problem-driven approach to enhance users' engagement on data platforms [29], Ruijer et al. [24] investigated user requirements on open data platforms by using different scenarios. Their study found that specifying a scenario facilitated to identify users' requirements on open data platforms by providing contexts. These scholars concluded with the idea that open data platforms need a context-specific approach to encourage collaboration among users working towards solving societal issues together.

Several context-specific data platforms that aimed to solve specific social issues have been proposed to date. The following are some examples of where context was beneficial. Health Data NY [39] has been used for emergency responses to natural disasters, to bring awareness of health-related issues, and to make health care information transparent [16]. Crime mappings are a classic example of focusing on specific data and for providing open access to citizens in order to improve neighborhood safety [32]. Agencies in San Francisco developed a data-driven platform, TransBase [40] to address the locations and volume of pedestrian collisions, which helped to identify streets that need to be improved and for requesting funding [13].

4. METHODOLOGY

To explore the requirements, semi-structured interviews were conducted with the three groups of participants: 1) representatives of organizations involved in vitality, 2) government officials, and 3) citizens.

4.1 Semi-structured Interviews with Representatives of Organizations Involved in Vitality

The first set of semi-structured interviews was conducted with the VLL project partners to gain insights into their expectations and concerns on the DS. The eight project partners represented the businesses, the municipality, the research/education institute, and sports organizations involved in the project. Each interview took between one and two hours. Interview notes were taken by two interviewers. Throughout the interviews, the researchers addressed the stakeholders' "visions", "concerns", and "feature requirements" on the DS. To explicitly elicit the feature requirements, we used cards showing potential data platform features with graphics. Closed card sorting [34] was selected because we expected the stakeholders could engage more if some information was provided a-priori [7]. We audiotaped and photographed the results of the closed card sorting after acquiring consensus from the participants.

4.2 Semi-structured Interviews with Government Officials

The second set of semi-structured interviews was conducted with government officials (N=10). Throughout the first set of interviews, we found that data availability was the major concern on the DS from the project partners. Since governments are considered as one of the key data providers for open data platforms [8], the purpose of these interviews is to understand the perspective of data providers regarding vitality, vitality data, and availability of vitality data to the DS. Convenience sampling was used at the design event "Dutch Design Week" in the Netherlands in 2019, in which governments exhibit their projects to visitors. In the interviews, we asked the participants the following questions: (i) What is vitality? (ii) What vitality data is required from the DS? and (iii) Would you be able to provide any vitality related data to the DS? First, the researcher confirmed with the participants regarding the procedure and the purpose of this interview. After that the participants were informed about the VLL project and the DS, which we plan to develop. The participants were asked to answer each question from the governments' point of view (and not as individuals) to capture the perspectives of the potential data providers on those questions.

4.3 Semi-structured Interviews with Citizens

The third set of semi-structured interviews was conducted with citizens (N=20), to understand the perception of vitality and the kinds of vitality data that should be integrated into the DS. For these interviews, we adapted the same methodology as used in the second set of interviews with government officials except we asked the participants their individual points of view. Similarly, we used convenience sampling at the design event "Dutch Design Week" in the Netherlands in 2019.

5. RESULTS

In this section, we present the results of the semi-structured interviews with our three target groups.

5.1 Semi-structured Interviews with Representatives of Organizations Involved in Vitality

Thematic analysis [4] was applied to analyze the data obtained from the semi-structured interviews with the

eight project partners. A deductive coding approach was implemented to guide the analysis based on the researchers' theoretical and analytical interests [4]. In particular, audio recordings were coded on a sentence by sentence basis based on whether they express *visions* or *concerns* about the DS. Later, a constant comparative method [3] was applied to organize key phrases within the themes as shown in Table 1.

In the theme of *concerns*, four participants stated "data availability" as their concern. "Lack of knowledge or expertise" was also remarkable, which was mentioned by three participants. From the theme of *visions*, five participants addressed the promotional and branding aspect of the project. Following this finding, "adaptability/ scalability", "business creation/ enhancement", "connection/ collaboration", "data collection", "data visualization", "intervention", "verification" (each addressed by three participants), and "data sharing", sustainability/continuity", and "vitality indicator" (each addressed by two participants) have emerged in *visions*.

Table 1: Interview participants' vision and concerns on the DS

Participants	Visions	Concerns
Business 1 Director of an international sports management agency	- Encourage data sharing - Enhance stakeholders' connections - Dynamic visualization of the data - Expand to a global system	- Data availability - Data privacy - Ownership of the DS
Business 2 Owner of an advisory organization in innovation management	- Encourage data sharing - Provide evidence by data - Showing how "smart city" can be realized - Self-sustainable data fits all stakeholders - Citizen's participation	- Difficult to reach social domains - Lack of evidence in the domain of vitality
Municipality 1 Area manager of a park	- Make people vital - Create a vitality indicator - Verify the contribution of parks for vitality - Gather public interests	- Data availability - Data source and status (unorganized and not ready for use)
Municipality 2 Sports program leader	- Collect public data - Make public space attractive for physical activities - Measure the results of implementations (e.g., public projects) - Provide data and insights to business	- Data availability - Inefficiency of data management at the municipality - Inadaptability of data visualization to diverse users
Sports Organization 1 Cluster manager for sports innovation	- Create a system sports organizations trust - Define vitality data	- Lack of legal and technical expertise with regard to data - Data availability
Sports Organization 2 Manager at a sports organization	- Create awareness of how technology contributes to a vital life - Data-driven policy making, innovation, and business creation - Collect various data - Create a scalable system	- Neglection of data and its potential
Research/Education 1 Program manager at a non-profit R&D organization	- Build a strong ecosystem - Gain insights from citizens - Foster startups/entrepreneurship - Support inspirations and the validation of ideas by visualizations	- Lack of knowledge to maintain the DS
Research/Education 2 Program director of vitality at a university	- Adapt to specific and general cases - Be a long-term project - Connect people and agencies - Support citizens to become more active by data visualizations	- Lack of knowledge about data among the stakeholders

The results of the card sorting were analyzed in order to investigate specific requirements for the features of the DS. We ranked the order of the card sorting results by reviewing the photos taken at the end of each interview. We assigned ranks to the following categories created by the participants during the interviews: (4: Core / Base / Must / Essential, 3: Need to have / Main or basic features, 2: Nice to have / Insights / Optional, 1: Later / Ambition / Extra, 0: Unnecessary). The data from one participant was not included in this analysis since we could not fit his card sorting categories into the ranking scheme. This participant categorized the features without any inherent hierarchy. The final ranks of required features with aggregated points (in brackets) was as follows: Dashboard (23), Data Visualization (23), Login/Authorization (22), Data Analysis (20), Help Navigation (20), Sorting and Filtering (20), Data Sharing (19), Quick Guides (18), Data Upload (17), Contact Data Provider (15), Data Auto Update (15), Data Download (15), Notifications (15), Health Parameters (14), Comments on Data (13), Street Parameters (13), General Comments (12), Real-Time Data (12), Route Planner (7). Several participants stated that separation between the project partners and general users is needed. This indicates that the DS likely needs the feature of authorization. The municipality and the research/education institute intended to open this platform to citizens. Half of the participants showed their interest in data generated from citizens.

As half of the participants showed their concern about data availability, we considered the importance to explore what types of data related to vitality could be provided to the DS. Two participants explicitly mentioned the government's role as a data provider throughout the interviews. Regarding citizens, five out of eight participants indicated the necessity of citizens' involvement in the DS as users.

5.2 Semi-structured Interviews with Governments

The data was analyzed using the KJ-Method in order to organize the qualitative data into categories for ideation and prioritization [26]. Researchers investigated the keywords obtained from the semi-structured interviews with citizens (extracting all nouns, which answered the questions) to explore the three aforementioned questions.

We generated 27 keywords from the first question, 25 keywords from the second question, and 13 keywords from the third question. After the emersion of these keywords, we used Post-It notes to write down each keyword on them and place them on large papers to investigate the similarity and difference among the keywords. Then, we organized them into categories.

Regarding the first question asking the definition of vitality, "health" emerged as the largest category, containing a total of 8 keywords including "food" and "sleep". Following "health", the category of "condition" (7 keywords: balance, freedom, stress free, etc.), "social" (5 keywords: community, family, togetherness, etc.), "capability" (4 keywords: capability, flexibility, positivity, etc.), "change" (2 keywords: a new paradigm and fresh) and "sustainability" (1 keyword: sustainability) emerged.

Generally, we found the relationship of vitality with a physical status [25, 27], emotion [22], and social contexts [22, 25, 28], which is in line with prior researches. "Condition", "change", and "sustainability" are unexpected categories generated from this question. These categories may have emerged by the influence of the governments' view as taking vitality from a more holistic view. For example, one participant explains "balance" as the balance of functions (e.g., the impact of agriculture on other factors) in a region.

Regarding the vitality data on the DS, "environment" forms the largest category from the second question, including 8 keywords such as spatial planning, geographic data, and pollution. This result was remarkable as the government officials consider the relation of environmental (spatial) data and vitality.

"Health" was the second largest category, containing 7 keywords. Other than those two major categories, we generated the categories of "social", sports/exercise", "food" and "work". In terms of "work", this was generated with relation to a participant's specific role as a government official. The single participant who mentioned keywords in the category of "work" indicated that her position includes to oversee businesses in the region under her jurisdiction. The keyword of "learnability" in the "work" category refers to the efficiency of learning tasks at companies according to this participant.

As with the first question, the physical, mental, and social dimensions of vitality data also appeared in the second question. Furthermore, we divided vitality data into low-level and high-level information since there is one keyword, "tips for health". We define this type of information as high-level (extraction, summary, or simplification of low-level information), which could be easily communicated to general users. In contrast, we consider low-level information as original reports and numerical (or statistical) data. Figure 1 shows the dimension of vitality data (keywords) and categories generated from the emerged keywords in the second question with government officials.

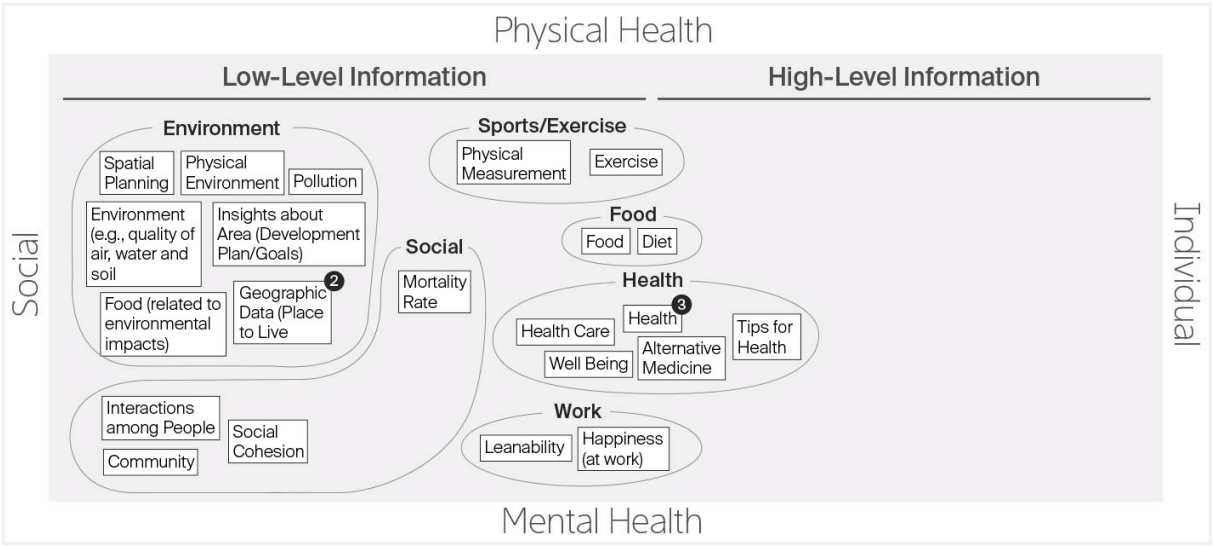

Figure 1: Dimensions of vitality data from the perspective of the government officials

Each card is a keyword obtained from the second question, i.e., what vitality data is required from the DS. Numbers in the top right corners of the keywords show how often the keyword was mentioned.

Seven categories were generated from the third question: "environment" (3 keywords: environment, air quality, and water quality), "policy and planning" (3 keywords: development plan, qualitative data such as reports and policy), "economy" (2 keywords: economy, working class), "transport" (2 keywords: traffic and mobility), "health" (1 keyword: health), "agriculture" (1 keyword: agriculture), and "local" (1 keyword: data from local governments). The third question has a much smaller number of keywords compared to the first and second questions. The fewer inputs can be partially attributed to the fact that four out of the ten government officials were not aware of what kind of (vitality) data government can provide. However, the results from the third question are important since these are the vitality related data that government officials consider available to the DS.

5.3 Semi-structured Interviews with Citizens

As above, we analyzed the data by using the KJ-Method [26] and generated 41 keywords from the first question, 39 keywords from the second question, and 7 keywords from the third question. Psychological, physical, subjective, and social dimensions of vitality and vitality data were observed in the analysis of the first and second questions, which is consistent with previous research such as Guérin [10], Penninx et al. [22], and Ryan and Frederick [25].

For the first question, "health" is primarily considered as vitality from the citizens' perspective, containing 14 keywords such as "mental health", "physical health", "well-being", and "healthy eating." Other categories, which emerged were: "stamina" (9 keywords: e.g., capability, endurance, resilience, motivation, and physical strength), "activeness" (6 keywords: e.g., energy, movement, and activeness), "happiness" (5 keywords: e.g., happiness, positivity, good feeling), "aliveness" (4 keywords: life, liveliness, power of life, living thing) and "social/environment" (3 keywords: family, society, and environment).

The major finding from the second question was that citizens generally expect high-level information such as tips related to health, food, and sports (22 out of 39 keywords) through the DS. Interest in food and nutrition was noticeable as reflected by 5 out of 39 keywords. 14 out of 39 keywords related to some status about vitality in the society such as activities and social classes. In contrast, 4 out of 39 keywords indicated highly subjective vitality data, such as personal evaluation through the DS. Figure 2 shows the dimension of vitality data created from the results of the second question with the citizens.

Due to the few keywords arising from the third question we refrained from creating categories. Only seven out of twenty participants answered that they would be able to provide their vitality data to the DS. Activity data (e.g., travel distance, exercise, food consumption, and sleep) from their smartphones is the major type of data they could provide. A few of them showed interest in receiving feedback and evaluation to improve vitality based on the activity data they share. Regardless of the limited responses, this finding indicates potential of providing citizens' data to the project partners with close consideration of data privacy policies such as the General Data Protection Regulation [30].

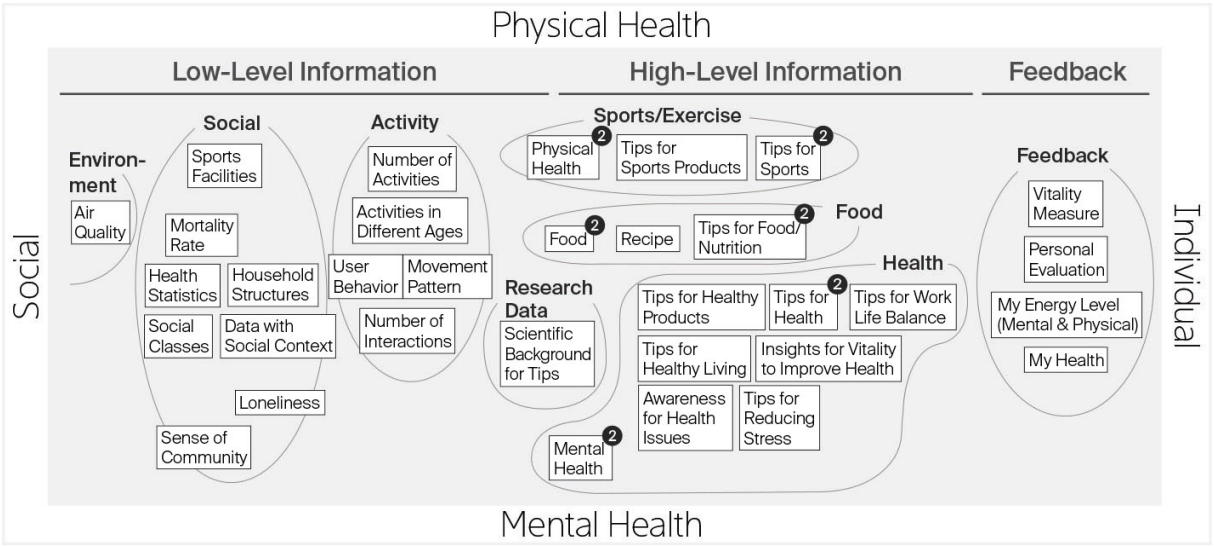

Figure 2: Dimensions of vitality data from the perspective of the citizens

Each card is a keyword obtained from the second question, i.e., what vitality data is required from the DS. Numbers in the top right corners of the keywords show how often the keyword was mentioned.

6. DISCUSSION

We conducted semi-structured interviews with the VLL project partners, government officials, and citizens to understand the requirements for the DS. Throughout the interviews, we also identified the types of vitality data that government officials and citizens expect on such data platform. Our study confirmed that vitality is multifactorial and subjective as is the concept of vitality itself, as also evident from past studies [25,28]. In addition, we found that government officials consider vitality more holistically such as the balance of functions in a region (e.g., the impact of agriculture on the environment).

Based on the interviews with the project partners, we found their expectation on the DS to support their decision-making process by providing low-level data and to enhance the connection among them and citizens. Citizen generated data (e.g., movement and behavior) are also considered to support their objectives. The major concern among the project partners was the availability of vitality data. Therefore, we conducted interviews with government officials, who could be potential data providers [8], and found that geographical data related to vitality such as environmental data (e.g., air quality) and development plans on a certain area, are likely available at governments in addition to health data. The results of the interviews with citizens indicated less interest in low-level data, but rather in tips about the topics they are interested in or worry about such as food, health, and exercise. However, we also found common interests in vitality related data between citizens and government officials. Both actors are interested in environmental data (e.g., air quality) of certain locations. This finding shows the potential of connecting governments and citizens. Such environmental data could be used by both actors. For instance, citizens can look at air quality data to decide where they live and governments can use the data for planning. Several scholars have been discussing the benefit of visual representation of data (such as maps in this specific case) [11,15,20,24,36,38]. As such, the extraction and simplification of low-level data are one of the considerable approaches to encourage engagement from citizens, who may be non-technical users and/or have low data literacy. This consideration may also support the realization of one of the visions from the project partners, namely the citizens' involvement in the DS, by enhancing the accessibility of data.

To understand the requirements from multiple actors on the DS further, our study suggests features to support interaction between them, which is in line with several prior studies [19,20,24]. The project partners' major vision with the DS, "promotion and branding", could be realized through capturing those micro interactions of actors. This process may also result in technical change and societal impacts in the future [2].

Our study is based on the VLL project and as such highly case specific which, on the one hand, is beneficial as the application context plays an essential role in data platforms but also limits the generalizability in some way. Additionally, the study is limited to a specific region in the Netherlands and was conducted with a relatively small sample size. Studying in multiple regions and diverse cultures with a larger sample may yield different

conclusions. Nonetheless, our study contributed to understanding the requirements from multiple actors on a context-specific data platform in the domain of vitality. Yet, more, similar studies, with different approaches are needed in the future for further verification.

7. CONCLUSION

Our paper reports on results from semi-structured interviews to understand the requirements on a data platform among multiple actors in the domain of vitality. Our study confirmed the multi-dimensional aspects of vitality and vitality data and found diverse requirements within the project partners, government officials, and also between the project partners and the other actors. Organizations involved in vitality services and government officials generally expect low-level data for their decision making and planning. On the other hand, citizens strive to gain more general information to solve their current problems or concerns. This finding suggests that various levels of information are required on data platforms to satisfy the variety of actors and to connect them. Moreover, features to enhance social discussions are required that support interactions among various actors to understand their needs with each other. Further studies need to examine what different information is appreciated and which features enhance the connection among multiple actors.

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