[White Paper] PubliCo: Improving risk and crisis communication in the context of the COVID-19 crisis

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Introduction

Background

Since it first emerged in late 2019, COVID-19 has developed into a global pandemic of historic proportions, resulting in unprecedented loss of life and social and economic disruptions on a global scale. In addition to disease and death, the global public has faced increasingly restrictive policy measures as authorities attempt to control the spread of this deadly new disease. Measures evolved quickly from relatively unencumbering recommendations, such as frequent handwashing, to more disruptive interventions, including border closures, school closures, restrictions on the size of gatherings, cancelation of events involving large gatherings, and even stay-at-home orders of varying severity.

Currently, over 100 million people worldwide have been infected by COVID-19 and over 2 million have died[1], including over 500,000 cases and 8,000 deaths in Switzerland [2]. However, the negative effects of the pandemic extend far beyond case counts and death tolls, and include a pandemic-induced global recession [3], negative mental health impacts [4, 5], food insecurity [6], breaks in education [7], and many more. After initial disruptions in the winter and spring of 2020, fears of a second wave quickly proved themselves well-founded in the fall, with new restrictions mounting across the world as the disease situation worsens.

Thus, in less than a year, the global public has faced a novel, highly contagious and potentially deadly disease, disease control measures that have had a profound effect on all aspects of their lives, and the complexities of a pandemic-induced global recession. In the face of these many challenges, it is not surprising that the public can struggle to understand evolving knowledge and recommendations. Adding to this confusion is the flood of rumors, half-truths and out-right false news that has accompanied the pandemic, spreading rapidly through social and even traditional media. This “Infodemic” complicates public health authorities’ efforts to devise an appropriate response to the pandemic and to effectively communicate with the public [8].

In Switzerland measures have been less restrictive than in many other countries, although a worsening situation throughout the fall of 2020 has led to increasingly strict public health measures, including nation-wide mask mandates, curfews, restaurant and bar closures, severe limits on the size of both public and private gatherings, and others[9]. Periodic public opinion surveys show that the population has generally supported public health measures, with at least 50% of respondents declaring that they were for various public health measures instituted in response to the pandemic in monthly surveys from March to June 2020[10-13]. However, a fifth survey at the beginning of the second wave in late October found lower levels of support, with only 30-43% of respondents saying that the responses were appropriate, while 41-50% felt that they didn’t go far enough [14].

Surveys also show polarization and controversy over various potential measures, including mask mandates and vaccine-update intentions [14]. Yet there are limits to what we can learn from these types of public opinion surveys, as shifting findings regarding public support for mask mandates illustrates. When first asked about mask mandates in indoor public spaces in April, 53% of respondents were against such measures. By June, opposition had grown to 63% [14]. Indeed, the Confederation chose not to implement such a mandate over the summer, instead mandating masks on public transportation only in early July. While some cantons instituted indoor mask mandates earlier, the Confederation as a whole did not institute one until October 18 [15], when forced to do so by one of the worst outbreaks in Europe. The next public opinion survey asking about indoor mask mandates was conducted about a week later, and it found that over 76% of respondents favored the measure [14]. As noted above, the same survey found that a plurality of respondents thought the government was not going far enough in responding to the pandemic, suggesting that support for

increasing restrictions, including mask mandates, may have shifted between early July and late October. However, it is hard to know when and how this change occurred as no surveys were conducted in that period.

While they offer a helpful snapshot of public opinion and experience, there are limits to cross-sectional public opinion polls' utility in informing public policy during an unfolding crisis. They are resource-intensive and necessarily limited in scope, questions are typically designed in a top-down way, they struggle with high non-response rates[16] and provide snapshots rather than continuous monitoring. In rapidly changing crisis situations, the later is particularly important, as public opinion can shift rapidly in the face of emerging knowledge and changing situations, as appears to be the case regarding mask mandates in Switzerland between early July and late October 2020. A better sense of the public's evolving opinions would allow more timely changes in public health responses, influencing both communication strategies and policy choices. It would also help us understand to what extent policy decisions match with citizens' moral values and preferences regarding, e.g., the allocation of scarce medical resources, personal or digital contact tracing, or obligatory mask wearing [17].

Opinion surveys are also a form of "one-way" communication. While they allow a better understanding of the public's experiences and attitudes, survey takers do not influence themes addressed in the survey or receive information in return. During an "Infodemic", this lack of feedback can be seen as a missed opportunity to provide high quality information. Survey-takers lack of influence on the questions asked in surveys also represents a possible missed opportunity to learn about different perspectives or about unanticipated challenges faced by particular sub-groups of the population.

Use of qualitative methods, like diary methods, could help address these challenges, as they allow participants to more fully explain their own perspective and discuss topics that they find relevant or high priorities, without the constraints typical of survey questions [18, 19]. Qualitative solicited diaries can provide "unique insights into the life-worlds inhabited by individuals; their experiences, actions, behaviors, and emotions and how these are played out across time and space"[19]. The diary approach empowers citizens to integrate their personal experiences and perceptions [20] while remaining in control not only of the content described but also of the pace and time of data collection[19]. In this way, this participatory method allows citizens to contribute their diverse views to the research process and enables the visualization of everyday negotiation processes in real time due to the immediacy of documentation [18, 19].

The limitations of public opinion surveys beg the question: could alternative methods of assessing public perceptions offer more timely and nuanced insights into evolving public perceptions during crisis situations, like the current COVID-19 pandemic? Such methods should combine qualitative and quantitative assessments of public perception, allow for continuous monitoring of public sentiment, and help combat rumors and misinformation by providing high-quality information to participants.

Concept

PubliCo is an experimental online platform that collects real-time data on COVID-19-related public perception; provides tailored, timely and reliable information to the public; and facilitates the development of well-targeted public health measures and communication strategies. As assessed by the Cantonal Ethics Committee of Canton Zurich, PubliCo does not fall under the scope of the Swiss Human Research Act (BASEC Nr. 2020-02917). Our risk assessment and data protection plan were also reviewed and approved by CEBES, the institutional review board of the IBME at the University of Zurich.

Figure 1 shows how the platform works. The public "front-end" interface allows users to participate in an online survey or in diary keeping. In return, they receive information tailored to their individual situation, based on their survey responses. The "back end" allows policy makers to access and analyze the data

collected, with an interface that allow users to define complex queries based on time, location, demographic characteristics or other characteristics. Results of these analyses should provide nuanced, actionable information for policymakers.

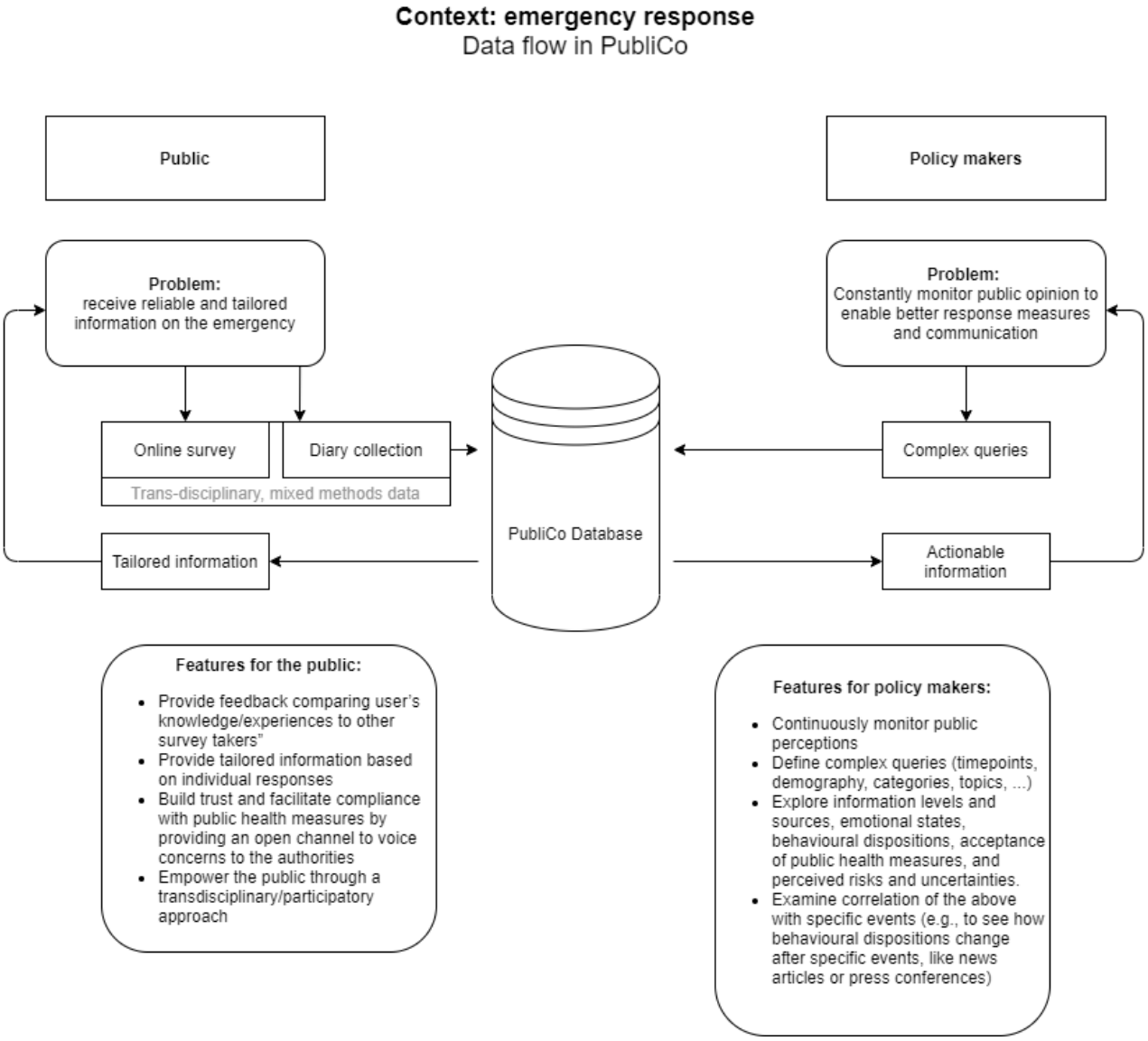

Figure 1. PubliCo conceptual structure: after completing a short survey (PubliCo Survey), citizens can receive information tailored to their needs. Users can also register as citizen scientists and contribute diaries (PubliCo Diaries). Policy makers can study the information provided by citizens in order to conceive, deploy and evaluate more efficient mitigation and containment measures (PubliCo Analytics).

Open science by design

We believe that, in the current context, adopting a democratic, bottom-up approach to designing and developing PubliCo would greatly improve public perception of the project while allowing us to tackle urgent and unforeseen issues [21]. As such, every component of PubliCo will be publicly available: the research project, the intermediate datasets and the software used to compile them, the source code, the raw data and the interpretative briefs. The only data that will be subject to manual check before release is the raw text of the diaries, which will be anonymized through removal of direct or indirect identifiers and not available to anyone outside of the research team in full-text form for analysis.

Citizen scientists will also be involved in the development of the survey and of the feedback provided to platform users. This will be accomplished through the web-based project builder of the Citizen Science Center Zurich [22].

This setup will increase trust in the project, encourage secondary use of PubliCo data, and ease the implementation of the tool in other countries.

Methods

The project combines analytical work and empirical studies using mixed methods and strong citizen science components in order to deliver a functional platform composed of three main elements: PubliCo Survey; PubliCo Diaries, PubliCo Analytics.

PubliCo Survey is a web-based survey that serves as the main source of quantitative information. Users answer questions about their demographic characteristics, knowledge of COVID-19, behavior, emotional state, and moral preferences for COVID-19 related issues. Based on demographic characteristics and scores on selected subscales, citizens obtain information relevant to their needs. The survey continuously collects data and can continuously be adapt examine new, emerging issues, thus providing real-time data on public perception and readiness to cooperate with public health strategies.

PubliCo Diaries is the main source of qualitative information. Users register as citizen scientists and keep a weekly diary for four weeks. They record their reflections on how COVID-19 and related policy measures affect their daily routine, social practices, values and priorities. Citizen scientists may also keep their diaries offline or record audio files and have the text entered by project staff. This ensures that gaps in access to or familiarity with technology don't prevent participation. PubliCo Diaries attempts to reach diverse groups of citizens affected by the pandemic in different ways, including pregnant women, older people, people whose work has been negatively affected by the pandemic and mitigation measures, youth or people with a migration background.

PubliCo Analytics will be the "access door" to the data collected through media analysis, the survey and the diaries. It will provide information to be used for analyses directed to policy-makers regarding Swiss residents' knowledge of COVID-19, reported pandemic-relevant behavior, emotional states and moral preferences. It also allows analysis of correlations of, e.g., vaccine prioritization preference and demographic sub-groups or support of preventive measures and COVID-19 experience. Finally, PubliCo Analytics will contain thematically focused policy briefs, in which we contextualize the data, interpret core findings, and make recommendations.

Development

The PubliCo platform is being developed in cooperation with Belka, a software house based in Trento/Munich, with extensive expertise in user experience design and development. The tool is web-based, mobile first, and is built on a stack of open source software (React, SurveyJS, Typescript, Django, MariaDB, Docker, CicleCI, NGINX). Particular attention is being devoted to the development of a backend for researchers, allowing non-technical staff to add and modify both survey items and information for the users. The content management system supports a multilingual interface. User experience testing will help ensure the survey is clear and accessible to a large part of the Swiss population. In addition to work on creating and testing the platform as a whole, developing the PubliCo platform involves work to develop the three components of the platform: PubliCo Survey, PubliCo Diaries and PubliCo Analytics.

PubliCo Survey and user feedback development

For initial survey development, we identified the information needs of Swiss residents through a Google Trends analysis, the information available in the media through a NLP analysis, and the focuses of COVID-19 related behavioral and social science research (BSSR) through a review of existing surveys. Below we review the findings from these analyses before discussing how they informed the development of the first version of the PubliCo Survey. Ongoing media analysis will inform further survey development and changes as the project progresses.

What are people looking for?

We used Google Trends searches to retrieve all the queries regarding COVID-19 performed in Switzerland between January 2020 and July 2020. Table 1 reports the structure of the query as suggested by Mavragani and colleagues [20]. Google Trends data are publicly available for replication or confirmation purposes.

Table 1. Structure of the Google trends search on COVID-19

Query	Coronavirus + covid + 2019-nCoV + SARS-CoV2
Query type	Keyword
Timeframe	01/01/20 - 27/07/20
Date of search	27/07/2020
Data source	Web searches
Location	CH (by canton)
Query category	All

We analyzed the normalized hits per Canton over time and the top searches associated to the keywords in our list, defined by Google trends as “terms that are most frequently searched with the term you entered in the same search session, within the chosen category, country, or region” [21]. Google Trends does not provide raw numbers, only normalized hits, whose “values vary from 0 to 100. The value 0 does not necessarily indicate no searches, but rather indicates very low search volumes that are not included in the results.” [22].

Examining normalized hits per week shows a general national trend in the need for information about the crisis. There is an initial spike in February/March, after which searches normalize around a slightly higher baseline.

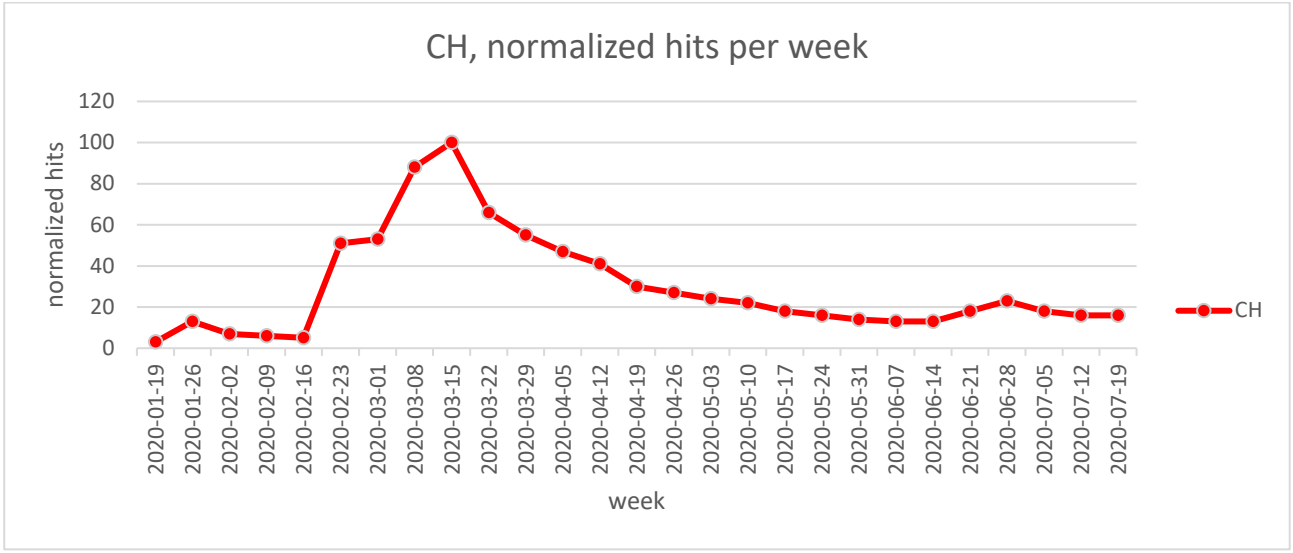

Figure 2. Normalized hits per week for COVID-19 related keywords in Switzerland.

This trend may be due to people needing a lot of "ontological" information about a new phenomenon when it appeared (for example, "what is coronavirus?"). Presumably, in the post-peak phase information needs centered on live updates and new regulations ("management information").

Top associated searches show what terms users used in conjunction with our keywords. We hand-coded the top associated searches, defining categories during the coding process. Table 2 lists, explains and gives examples of searches for the categories defined.

Table 2. Categories, definitions and examples of items attributed to each category.

Category name	**Explanation**	**Example**
geographical reference (place of residence)	Country, region or city where searcher lives	"Aargau coronavirus"
geographical reference (other place)	Country, region or city other than where searcher lives	"Deutschland coronavirus"
official body	Official organization	"coronavirus ofsp" "who coronavirus"
quantitative information	Number of cases, of deceased, or other statistics	"cas coronavirus suisse"
News	News (including place-specific and general)	"coronavirus news schweiz"
medical information	Information related to diagnosis, treatment or medical outcome	"coronavirus symptome"
Tips	Suggestions and advice	"coronavirus tipps"
live update	Live updates on the pandemic situation	"coronavirus schweiz aktuell"
general information	General information about the virus, the disease or the pandemic	"info coronavirus"

In Table 3, we report the count of the categories of the top associated searches. This shows what associated terms occur most frequently. We also report the mean count for all Swiss cantons, along with the standard deviation, minimum and maximum count. This shows the wide range in counts by canton, suggesting that residents of some cantons are more likely to pair searches for coronavirus with some categories, which suggests that information needs vary by canton.

Table 3. Category count and descriptive statistics.

Categories	**CH, Google Trends aggregated data**	**CH, mean per canton**	**CH, SD per canton**	**CH, min per canton**	**CH, max per canton**
geographical reference (place of residency)	9	7,23	2,83	1	11
geographical reference (other place)	5	3,38	1,98	0	6
News	3	2,12	1,18	0	4
quantitative information	1	2,04	1,56	0	4
general information	2	1,73	1,19	0	4
official body	1	1,04	0,60	0	2
medical information	2	0,92	0,63	0	2
live update	2	0,92	0,98	0	3
tips	0	0,54	0,51	0	1

The diversity of information people seek suggest that Swiss residents may welcome a system like PubliCo, which delivers personalized information.

What's in the media?

In order to understand how the media discuss and frame COVID-19 in Switzerland, we used Factiva, a news monitoring and search engine developed and owned by Dow Jones that has access to full text articles published by major media outlets worldwide. We gathered and downloaded all the news articles published between January and July 2020 on Covid-19 and Switzerland. Table 4 outlines the query.

Table 4, structure of the Factiva query

Syntax	**Meaning**
((coronavirus or Wuhan virus or corvid19 or corvid 19 or covid19 or covid 19 or ncov or novel coronavirus or sars) and (atleast3 coronavirus or atleast3 wuhan or atleast3 corvid* or atleast3 covid* or atleast3 ncov or atleast3 novel or atleast3 corona*))	Keywords for covid19; must appear at least 3 times in the text
and ns[1]=(gsars[2] or gout[3])	Subject is "novel coronaviruses" or "outbreaks and epidemics" and "general news"
and la=X	Language is X (DE, FR, IT, EN)
and rst=tmnb	Restrict to TMNB (major news and business publications)
and wc>300	At least 300 words
and date from 20191001 to 20200801	Date interval
and re=SWITZ	Region is Switzerland

1 "NS" is a descriptor for the content of the article.

2 "gsarsa" is "all news on Severe Acute Respiratory Syndrome."
3 "gout" is "the widespread occurrence of an infectious disease affecting many people or animals in a given population at the same time."

We included all articles about Switzerland rather than limiting to articles published by Swiss media because we wished to capture the information trends people are exposed to, which often extends beyond Swiss media itself, including in particular media from neighboring countries. We exclude publications under 300 words and duplicates identified by Factiva. After these exclusions, the search returned 1368 articles in English, 2925 in German, 639 in French and 157 in Italian. Figure 3 shows the number of articles found per language per month.

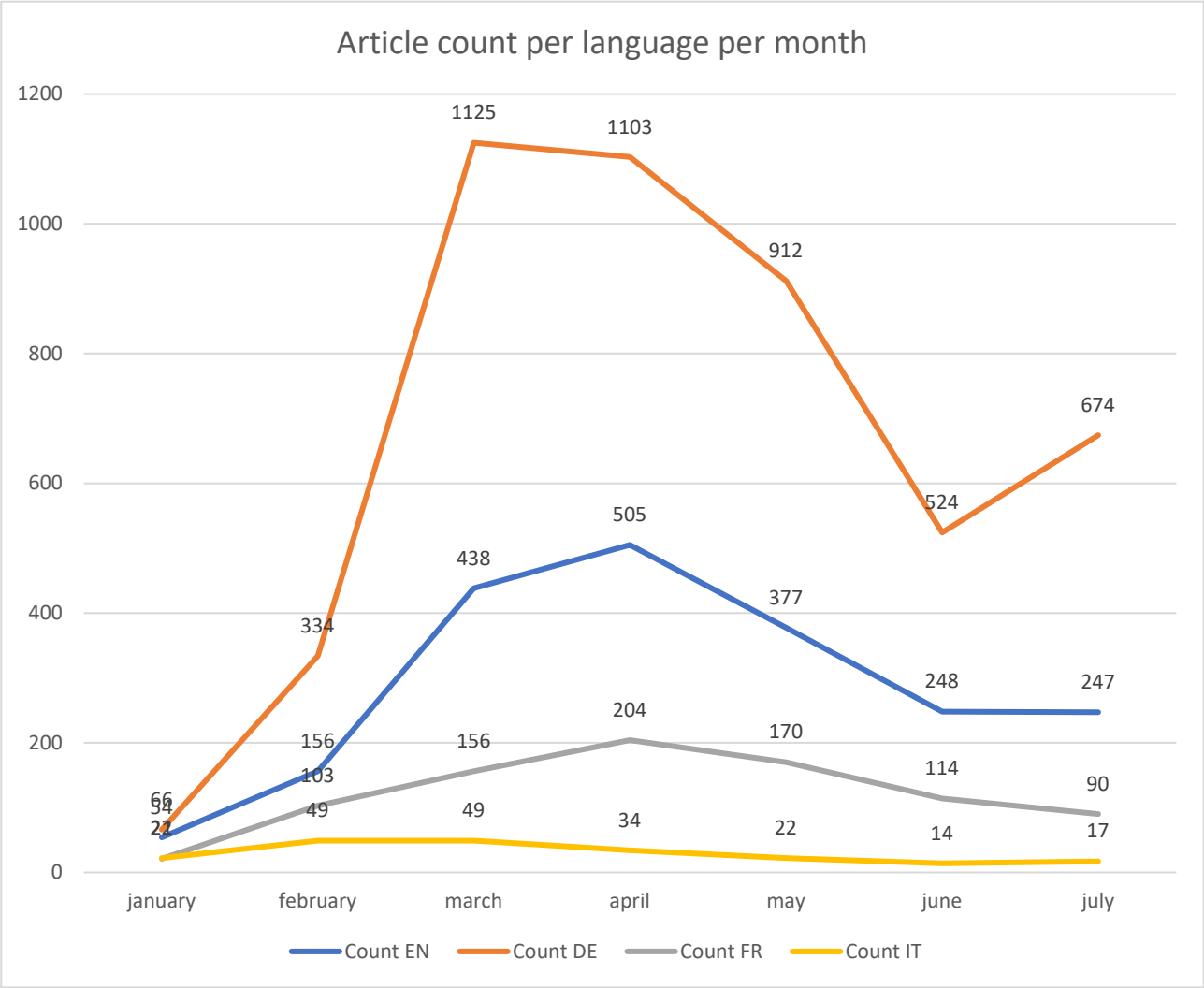

Figure 3. Article count per month. blue: English; orange: German; grey: French; yellow: Italian

We parsed the files downloaded from Factiva using regex rules to extract article ID, language, date, title, author and text. Articles were then saved in a new data frame and exported as a .csv file. This approach allows more refined segmentation of the text in the natural language processing pipeline, including limiting analysis to specific time intervals. The parser is available for confirmation and replication[24].

The overall idea of the natural language processing (NLP) pipeline, by means of lemmatization and named entity recognition (NER), is to reduce the corpora to a list of concepts to be tracked over time and compared to results of the Google trends data analysis. We used spaCy, a widely adopted Python library that together with Natural Language Toolkit (NLTK) represents the state of the art for NLP [25]. SpaCy supports over 59 languages, making it easy to replicate analyses in different languages. The analysis software and the resulting dataset are available for confirmation and replication [26].

We see differences across languages. The analysis of German lemmas indicates a public discourse focused on quantitative aspects of the pandemic (“prozent”, “million”, “milliarde”, “zahl”, “fall”). In comparison, the French subcorpus focused on describing the pandemic and its effects on people (“cas”, “crise”, “pandémie”, “personne”, “santé”). The Italian subcorpus focused more on cases and fatalities (“caso”, “contagiare”, “contagio”, “morto”). It is also the subcorpus in which “oms” (“Organizzazione Mondiale della Sanità”, i.e. World Health Organization (WHO)) ranks higher, indicating a higher attention for official WHO news and/or reports. Finally, the English subcorpus seems dominated by information reported from other

sources (“say”), which makes sense as English is not an official language of the Confederation. In addition to lemmas similar to those found in the other subcorpora, we also find many lemmas like “company”, “group”, “market”, suggesting greater attention to the economic and financial impact of the pandemic.

All the subcorpora provide the following macro-categories of information:

- georeferenced information (information specific to countries, Cantons or cities);
- general information about the pandemic and about the virus;
- reports from authorities and official bodies;
- quantitative information.

Named Entity Recognition (NER) is another, more refined technique employed in text mining to conflate texts. It is used for information extraction and retrieval, automatic summarization, automatic question answering and similar tasks [27-29]. NER can recognize the category (e.g. person, location, organization) of a given word, allowing the definition of subsets of concepts in the corpus, which allows it to compare how often a person or organization is named. In the context of this project, information extraction by means of NER serves the purpose of validating the lemma analysis while gathering more fine-grained information. The results of the analysis across the different corpora showed that neighboring or severely hit countries were primarily mentioned, along with federal/national health agencies and the WHO[24].

What are researchers looking for?

On the 14th of May 2020 the NIH Office of Behavioral and Social Sciences released a document listing “data collection instruments, including surveys, for assessing COVID-19-relevant BSSR domains for clinical or population research”[30].

In order to understand the foci of current BSS research related to COVID-19, we screened all the items of every survey in the NIH collection, classifying the topics covered in each survey and grouping them in categories. We identified 6 main categories and 35 subcategories, listed in Table 6.

Table 4. Categories and topics on which current COVID-19 BSSR research focuses

Category	**Topics**
Financial impact	Impacts on work & childcare; Deprivation
Social practices	Social connections; Social distancing; Social capital
Behavioral dispositions	Recent risky/protective behavior; Cleaning behavior; Work behavior; Coping behavior; Interpersonal conflict; Comparison with others; Anticipated vaccination behavior; Healthful behavior; Sleep; General disruptions
Moral preferences	Willingness to distance; Federal government response; State government response; City government response
Emotional state	Depression Screening; Anxiety Screening; Stress Scale; Resilience; Emotional Regulation; Loneliness; General Emotional Impact; Worries; Obsession with Covid; General Well-being; Cognitive Well-being; Sleep
Cognitive understanding	COVID-19 symptoms; What to do if symptomatic; COVID-19 Transmission; Self-protection

PubliCo SurveyA review of Google Trends and Factiva analyses identified 5 categories of information to collect and to provide through the first version of the PubliCo Survey:

- Demographics;
- Cognitive understanding;
- Behavioral dispositions;
- Emotional state;
- Moral preferences.

The NIH BSSR collection then provided a solid basis to start with for defining our own survey tool through comparison of survey instruments used in other surveys.

On this basis, we developed a short, fully anonymous web survey (approximately 15 minutes to complete) targeted at Swiss residents aged 18 or older with questions related to each of the 5 categories mentioned above. For demographics, we ask standard question about nationality, sex, age, canton of residence, and household composition. In addition, we ask for respondents' self-assessed health and about their personal experience with COVID-19.

To assess cognitive understanding we ask questions about users' knowledge of COVID-19 symptoms and actions individuals can take to prevent transmission. In addition, we gauge users' knowledge of official recommendations for what to do if they suspect they have COVID-19.

Behavioral dispositions is a broad category. Users are asked to report the frequency with which they engage in a wide-range of pandemic-associated behaviors, including both officially recommended behaviors like frequent hand-washing and mask wearing, other common protective behaviors that are not officially recommended, like avoiding all social gatherings, and behaviors that are commonly reported but not protective or even potentially harmful, like wearing disposable gloves when shopping or avoiding all outdoor exercise. This section also includes a question about users' perception of current public safety measures, assessment of how their behavior compares to others (are they doing more or less than others to slow virus transmission), anticipated vaccination behavior, and reasons for not wanting to be vaccinated, if they report that they are unlikely to do so. Finally, this section asks users to report the extent to which the pandemic has disrupted their ability to engage in social activities, work, exercise, leave their homes and receive emotional support from others over the last 7 days.

To gauge users' emotional state, we included the brief survey inventory 18 (BSI-18), an 18-item survey that allows measurement of respondents' anxiety, depression and somatization symptoms along with a global severity score to gauge their overall emotional state [31]. The BSI-18 is short and has been validated for use in Switzerland in all national languages [32] and used previously in Switzerland [33].

Finally, the questions on moral preferences deal with respondents' preferences for how the government should respond to the pandemic, including opinions about what types of responses are appropriate, how the government should respond to non-compliance, and trust in government. It also includes questions related to distribution and prioritization of COVID-19 tests and vaccines, if demand exceeds supplies, and on how much (if anything) users' should pay for tests or vaccines. This section also includes screening questions that are not strictly related to moral preferences, but help define appropriate sub-groups for analysis. For example, it includes a question about whether the user has ever received a COVID-19 test, and will include a similar questions related to COVID-19 vaccination once vaccination campaigns begin.

Upon completion of the survey, users automatically receive feedback based on their scores for specific items and reported demographic characteristics. For example, if responses indicate low levels of knowledge about COVID-19 symptoms or protective measures, users will be given information on these points and directed to reliable information sources, such as information provided by the Federal Office of Public Health (FOPH). If responses to the BSI-18 suggest they are in psychological distress, they will be directed to organizations and resources where they can access help and expert advice, etc.

Future versions of the survey will explore other issues of pressing concern that arise over the course of the pandemic, which we will identify based on renewed media analysis, analysis of PubliCo Diaries, and through consultation with experts and citizen scientists. We may also add further languages to reach out to minority groups that are not otherwise easily reached by policy-makers, like refugee populations. We are currently exploring whether we can add Tigrinya as a language through collaboration with a researcher conversant in this language. Doing so would enable us to use PubliCo to reach out to Ethiopian refugees in Switzerland.

PubliCo Diaries

While the PubliCo Survey is fully anonymous, diary keepers are asked to submit weekly diary entries over the course of 4 weeks. In order to associate diary entries with the correct diary keepers, entries cannot be fully anonymous. Instead, diary keepers create user accounts on the PubliCo platform where they submit their entries. They are asked to anonymize entries, which are also reviewed and further anonymized by project staff.

A primary goal of PubliCo Diaries is to learn more about the pandemic experiences of sub-groups of the Swiss population that are affected by the pandemic in particular ways. As such, there are two modes of recruitment for diary keepers. Users of the PubliCo platform can self-select to participate in the diary portion of the study. In addition, the research team will recruit selected groups of citizen scientists representing different population groups in Switzerland. Participants belonging to these diverse social groups will write at least one weekly open-format diary entries. These data will shed light on the everyday experiences and sentiments linked to Covid-19 and related public health measures for different vulnerable subgroups. Target groups could include young people, parents, pregnant women, older people, people with a migrant background, or people whose work is negatively affected by the pandemic (e.g. self-employment, artists and artisans and others) or who are on 'Kurzarbeit'.

In order to facilitate participation by sub-groups who may find online diary keeping cumbersome or intimidating due, e.g., to unfamiliarity with computer or smartphone technologies, the research team also gives diary keepers the possibility to submit typed, audio-recorded or handwritten diaries directly to researchers, who will then enter them into the platform. For individuals who are incapable of keeping diaries, researchers may also conduct individual interviews.

PubliCo Analytics

The third part of the PubliCo platform is PubliCo Analytics. In this "back-end" portion of the platform, users of PubliCo Analytics, which is primarily intended for researchers and policy-makers, can analyze the data submitted by survey-takers and diary-keepers.

Data analysis

PubliCo opens up the possibility to analyze data in multiple ways. Some data analytics are automated within the platform. Thus, users will have direct feedback for certain variables (e.g: information level, behavioral dispositions), including scores and official information based on responses to knowledge questions but also basic descriptive statistics (means and frequencies) for all users and specific sub-groups or respondents from specific cantons.

In addition, the PubliCo Analytics will interface will enable researchers, policy makers and other users to enter complex queries so that, e.g., they can compare knowledge or emotional states in different cantons, regions or sub-groups of the population or changes in participant responses over time. In addition, the interface will allow researchers and policy-makers to examine correlations between two variables like COVID-19 knowledge and vaccine uptake intention.

For analyzing diary entry data, users of PubliCo Analytics will not have direct access to the full content of diary entries due to data protection concerns. However, they will be able to analyze the content of the diaries using NER and NLP techniques.

The interface is intended to allow users of PubliCo Analytics to examine the data on their own to answer questions of interest to them. In addition, the PubliCo research team will also update media analyses and analyze diaries and survey results for periodic policy briefs. Questions to be examined will vary over time and will include basic descriptive statistics for the different domains included in the survey (knowledge, emotional state, behavioral dispositions and moral preferences), sub-group analyses by geographical area and target group, and correlation analyses. Questions to be examined through correlation analysis include:

- What is the relationship between participant knowledge and willingness to comply with public health restrictions?
- What is the relationship between participant knowledge and emotional state?
- What is the relationship between participant's emotional state and their willingness to comply with public health restrictions?
- What factors influence participants' moral preferences?

These and other questions will be analyzed using regression analysis with a significance level of $\alpha = 0.05$.

The statistical results presented in the policy briefs are complemented by the qualitative data analyisis of diary entires, which will be anonymized and analyzed using the Software MAXQDA [34].

Selected data will be displayed in PubliCo Analytics in a visually appealing form (e.g. infographs, live maps). Advanced analytics will be employed whenever possible (NLP for text elements, predictive modelling of, e.g., public behavior in case of new measures taken). Data collection will be adapted to how the situation evolves, taking up emerging themes (e.g. vaccine distribution; balancing work requirements and protection of persons with risk factors). Core findings and recommendations will be published in thematically focused policy briefs.

Data collection

Data collection will start with a pilot phase (December 2020 to February 2021), during which we will collect analytics on how the platform and its different tools are used. For this purpose, we will use a shorter version of the PubliCo Survey (which is currently under evaluation through Citizen Science Center Zurich). The tool is already able to collect and provide information, but we want to collect more bottom-up input before deploying the full survey.

Data collection for the diary component will start during the pilot phase. Researchers will recruit participants purposefully by contacting key informants in target groups and distributing flyers in locations likely to be frequented by potential diary keepers. Participants will be given a brief guide to the diary method, which will inform them about the openness of the method (e.g., without concerns about spelling and grammar). The guide will ask them to jot down a) their experiences and thoughts from the beginning of the pandemic to the current day and b) their everyday worries, emotions, risks, experiences, decisions and actions during and/or after the pandemic in at minimum a weekly rhythm for a duration of at least 4 weeks. This will allow "to document changes in values, attitudes, knowledge and behavior" [33].

In order to increase the user base, PubliCo will be disseminated through:

- General media through featured articles in order to reach the general population;
- Mailing lists of the Universities of Zurich and Basel in order to reach undergraduate and graduate students;

- A Facebook page and selected Facebook groups in order to reach selected target groups, including migrants and parents;
- LCH (Lehrerinnen und Lehrer Schweiz) in order to reach high school students;
- Participants of the Swiss branch of the DIPEx International Study on COVID-19 in order to reach people who had direct experience of COVID-19;
- A demoscopic company that will solicit a representative sample for comparative purposes.

The outboarding section will also invite the users to share the tool further via social media, email or similar systems, and to register as citizen scientists for the PubliCo Diaries component. We will also investigate possibilities of disseminating through official channels, like the automatic SMS sender of the Federal Office of Public Health.

Data collection will be iterative and will proceed for at least two years. We expect the tool to be refined and enhanced as data collection and analysis moves forward. The current version of the survey is available at www.publico.community.

Testing and validation

In order to improve all aspects of PubliCo, we have engaged in extensive outreach for feedback on the platform and the research approach. This outreach includes:

- Assembly of an project expert council for ongoing advice and an ad hoc group of national and international advisors for periodic feedback
- Public launch of the platform with attendance from the project expert council and adhoc group of national and international advisors members
- International workshop with experts and advisors
- Outreach to citizen scientists for review of survey questions included in PubliCo Survey
- Solicited feedback from experts in psychology on user feedback given to respondents based on their scores on the BSI-18, which we include in PubliCo Survey to gauge user's emotional state,
- Solicited feedback from public health authorities at the federal and cantonal levels on their needs and wishes from PubliCo Analytics

The project expert council includes 11 advisors with various backgrounds and expertise, including individuals with expertise in medicine, ethics, virology, psychology, economics, interaction design and journalism. The adhoc group of national and international advisors includes 46 additional advisors from 24 different countries, including Switzerland, China, Pakistan, Kazakhstan, Uganda, Iran, Kenya, Argentina, Canada, USA, Chile, India, South Korea, Australia, Singapore, South Africa, Hong Kong, Italy, Slovakia, Germany, Spain, Ireland, Sweden, and Slovenia.

The project expert council have given ongoing feedback throughout project development. In addition, all advisors were invited to attend the PubliCo Launch on November 30, 2020, and a follow-up workshop one week later on December 7, 2020 to give specific feedback on the project.

PubliCo Launch & International Workshop with Experts and Advisors

The research team introduced the platform at the PubliCo launch on November 30, 2020. The launch was an open Zoom event, including participation from the PubliCo team, the project expert council, the adhoc group of national and international advisors, local journalists and contributions from Christian Ritter of the Collegium Helveticum, Tim Nguyen of the WHO health emergencies program and Rosy Mondardini of the Citizen Science Centre Zurich.

During the launch, presenters discussed the infodemic in the context of COVID-19, the core idea of PubliCo, the strategy we developed to realize that idea, the structure of the platform, the role of citizen scientists in

project design, plans to publicize the experience, and possible future uses of similar platforms in other contexts. The launch ended with a demonstration of how the platform works and a brief question and answer period. The launch was recorded so that people who were unable to attend could view the event at a later date.

The main purpose of the launch was to introduce the beta version of the platform to advisors, citizen scientist reviewers, and the public for testing. Then, a week later, we held our first consultative workshop with our project expert council and adhoc group of national and international advisors for specific feedback on the platform. We solicited feedback on five points:

- Information needs and sources of policy makers
- Content, information sources, and presentation of information to the public who uses PubliCo
- Emerging issues in the development of the Pandemic and Pandemic response to consider
- How to improve the platform
- Transferability of the concept to other settings, including low and middle-income countries

With regards to the information needs of policy makers, expert council and advisors emphasized the important role of scientists in making data accessible to policy makers, who may not be able or willing to interpret this data in a meaningful way through use of the features of PubliCo Analytics. This will require constant updates to both contents of the survey and to the issues included in PubliCo policy briefs. A continued dialogue with policy-makers is also important here. Finally, advisors also urged the team to consider a broader array of stakeholders in conceiving of the project, including not only public health authorities and the public, but also scientists.

With regards to feedback given to participants, particularly in PubliCo Survey, expert council and advisors emphasized the need to keep feedback succinct and provide visual rather than text feedback as much as possible. This is particularly important for information designed to be accessed via smartphone. In addition, favoring more visual communication could improve transferability to other contexts, especially places with lower levels of literacy. Expert council and advisors pointed out that current feedback is fairly unsatisfactory, and urged more feedback about, for example, how respondents compare to each other. This is planned and will be included in the user feedback once a sufficient number of people have completed the survey to make such feedback meaningful.

Future issues to explore with PubliCo that expert council and advisors raised include the core issue of trust in public health authorities, the government and biomedicine, particularly in the context of the deployment of new COVID-19 vaccines. Expert council and advisors also emphasized the importance of this issue cross-nationally, as trust in government authorities varies quite widely. They also suggested that the team prepare modules addressing certain foreseeable issues, like reactions to holidays, vaccine distribution, announced changes in public health measures, etc., so that they could be deployed in a timely manner when needed.

When discussing how to improve the platform, one important subject of discussion was the challenges and need to reach a broad and representative portion of the population through the platform in order to ensure that the data produced isn't biased. Public opinion surveys are generally asked to a representative sample of the population in order to ensure that responses represent the diverse views of the population in a representative way. However, a web-survey whose users self-select to participate would not be representative. Based on this concern, the team is pursuing collecting some survey responses from a representative sample of the population, either for one period or over time, so that this representative data can be compared to the data from individuals who self-select to take the survey. This will enable us to see how the responses from self-selecting users compare to a more traditional representative sample and thus check and potentially correct for biases. We can also compare the socio-demographic characteristics

of participants in PubliCo Survey with those of participants in more traditional public opinion polls related to the pandemic in Switzerland, such as the Sotomo surveys mentioned above.

In a similar way, a portion of PubliCo Diaries keepers will be purposively sampled by the research team, and their diaries will be compared to those from people who self-select to participate, allowing the research team to gauge how diary keepers from the different groups compare. Advisors also pointed to problems with the language display, with information not always displaying in the correct language or links not being language-specific (for example, when referring users to the BAG).

With regards to transferability to other contexts, the expert council and advisors highlighted that the internet-dependency of the platform could make its use difficult in low-technology settings. Substantial changes might be needed to make this approach workable in areas with low rates of internet access. The platform is built to work with lower-speed data connectivity, but still requires technological ability to connect to the internet. The expert council and advisors also emphasized the importance of considering cultural, political and economic issues when adapting the platform for use in a different country, which effects everything from ethics approval to data hosting to the images used on sites. One major issue to consider is the digital divide in lower and middle income countries. While large portions of the population have access to technology and are comfortable using it, there are also large portions of the population that do not have access or are not comfortable with such technologies, so techniques to reach out to both populations are needed. One way of overcoming these challenges could involve reaching out to portions of the population that are not digitally connected through, for example, community health workers.

Based on this feedback, the research team has been working together with the platform developer, Belka, to revise and update the PubliCo.

Citizen Science Feedback and Feedback from Experts in Psychology

By mid-December, we had received feedback on the survey questions from 17 citizen scientists, and we have solicited further feedback from public health students. Initial feedback is very helpful in identifying questions that need to be rethought or additional issues that we ought to include, like questions related to the use of the Swiss government's COVID-19 tracing app, SwissCovid, and questions specifically for parents of young children dealing with challenges of parenting in a pandemic. We will review all feedback from citizen scientists in early 2021 and adjust the survey based on this review.

As mentioned above, survey users receive feedback on selected measures, including their response to the 18-item BSI, which is included in the online survey to get an overall sense of individuals' emotional state during the COVID-19 pandemic. Given the sensitivity of these measures and the widespread toll that the COVID-19 pandemic and accompanying mitigation measures have had on mental health for large groups in the population, we took particular care in developing user feedback on these measures, consulting with experts in psychology for specific advice on how to best approach such feedback.

To this end, we sent three experts excerpts of the scores and a draft of our intended feedback based on these measures and requested their advice and corrections for any feedback we might give. Based on their advice, we will adjust the feedback based on these scores to include a disclaimer noting the limits of assessment and information on mental health resources to contact in case of distress. In addition, we will adjust the feedback on the somatization portion of the score.

Future testing and validation: PubliCo Analytics

The next phase in testing and validating the platform involves the PubliCo Analytics portion of the platform. As this part of the platform performs data analysis, it is not possible to fully test it until we have collected more data via PubliCo Survey and PubliCo Diaries. Once a first period of data collection via PubliCo Surveys and PubliCo Diaries is complete, we will begin serious review of this portion of the platform.

We will hold an advisory workshop with members of our project expert council and adhoc group of national and international advisors who work in or have expertise in public health and with governmental public health authorities at the federal and cantonal levels in early spring 2021, after the release of the first PubliCo policy brief, which will include analyses of survey data, diary entries and an updated media analysis using Google Trends and Factiva.

Lessons from PubliCo

Public participation through a citizen scientist approach is a key value of PubliCo. This value expresses itself in three key ways in this project. First, a key goal of PubliCo is to improve communication in an emergency context by fostering continuous bi-directional communication between the public and public health authorities. Continuous bi-directional communication could help improve the development of better response measures to the COVID-19 pandemic by, for example, enabling authorities to see changes in public perception more quickly, and adapt responses accordingly. This, in turn, can help foster public trust by making the public more confident that public health authorities hear and consider their concerns. In keeping with the goal of fostering open communication in a crisis context, we feel that it is important to involve the public in the design and development of tools used in PubliCo. This is why we work in cooperation with the citizen scientists through the Citizen Science Centre Zurich for refining PubliCo Survey. PubliCo Diaries also plays an important role here. Diary writing is often seen as an empowering activity, and our sampling strategy aims to integrate groups that may not otherwise be heard, which is particularly important for ensuring equity in our citizen science outreach efforts.

Second, we support citizen involvement and foster public trust by being transparent about all aspects of the project, from research design and development to data management. To this end, information on all aspects of the PubliCo project is openly accessible on the PubliCo project page on the IBME website. This site provides detailed resources, including information that enables replication of the Factiva and Google Trends analyses discussed above [24, 26] and the research protocol for the project [34]. It also hosts recordings of key project events, like the PubliCo launch.

A third aspect of public participation involves the public's access to the results of research conducted using their contributions. PubliCo assures this access three ways. First, it allows the public to analyze the data directly using PubliCo Analytics. Second, it makes the research teams periodic PubliCo policy briefs open to all through the PubliCo Analytics portion of the website. Third, all peer-reviewed scientific publications based on PubliCo data will be published open access and links will be provided through the IBME's PubliCo web page.

In addition to community involvement in research, transparency and open access to the results of research, data protection is an important part of fostering public trust. One way we protect participants' data is by ensuring that they cannot be identified through their contributions. To this end, PubliCo Survey is completely anonymous by design and the platform does not collect users' IP addresses. As completed surveys are not linked in any way, this is possible. PubliCo Diaries cannot be fully anonymous, as we ask diary keepers to submit multiple linked entries. Instead it is pseudonymous (we can attribute diaries to users, but we cannot attribute users to persons). However, this does not fully ensure the protection of diary keepers, as information from their diary entries could possibly make them identifiable. As such, members of the research team will review and anonymize diary entries, and users of PubliCo Analytics are not given access to the full text of diary entries for analysis. In addition, some diary keepers will be recruited directly by the research team and will submit diary entries to the team directly. We take additional steps to protect these individuals, as they are not participating in an anonymous or pseudonymous way. Personal sensitive information resulting from the diaries will be pseudonymized. The identification keys will be encrypted with SHA-256 functions and archived for at least ten years on the servers of the Institute of Biomedical Ethics

and History of Medicine. To further ensure data security, all data is stored in virtual machines hosted in the data center of the University of Zurich with access restricted to the project members.

Challenges and Limitations

PubliCo faces three main challenges. First, how does the team ensure that data collected through self-selection reaches a broad and somewhat representative portion of the population? There are two possible solutions to this problem. First, the team can solicit a representative sample and a self-selected sample in parallel and compare the findings from each. Alternatively, the project could focus on soliciting feedback from specific target groups that aren't well-represented in other efforts, such as periodic opinion polling, to ensure that their concerns are also heard.

Another challenge is keeping questions, user feedback and researcher-produced analytics (PubliCo policy briefs) timely in the fast-changing context of the current pandemic while also keeping content rigorous, maintaining an attractive user experience, and fostering community and expert feedback throughout the research project. While the platform can be adapted to changing circumstances, updates to survey questions, feedback to users, and analytic possibilities requires active engagement from the research team.

Finally, transferring this approach to other contexts provides its own challenges in adapting content to be culturally and technologically appropriate. In addition, care must be taken in certain political climates to ensure that the tool is used in collaboration with citizens and not as a tool of surveillance and social control. Doing so would require collaboration with local actors capable of carrying out this adaptation process and supporting the ongoing research. In addition, teams would need to consider how to address the issue of the digital divide. More extensive adaptations to the approach might be needed in contexts with low-levels of internet access.

Future Outlook

We are collaborating with colleagues in Hong Kong and Singapore to explore whether the PubliCo platform can add value to and/or learn from those contexts. Anticipated partnerships include a partnership with the Centre for Medical Ethics and Law, Li Ka Shing School of Medicine and Faculty of Law, University of Hong Kong, represented by Dr. Calvin Ho and ETH Zurich through its Future Resilience Systems Program (FRS) hosted by the Singapore ETH Center (SEC), represented by Prof. Dr. Renate Schubert.

Through these partnerships, we hope to not only expand the PubliCo approach across other Asian countries but also probe the role of "good" crisis communication and management around COVID-19 to better deal with the pandemic. The Future Resilience Systems Program (FRS) at the Singapore ETH Center (SEC), represented by Prof. Schubert, will provide important insight to the project, given its important recent studies on improving resilience in the context COVID-19. We believe the ethical, legal, economic, cultural and political issues around pandemic preparedness will provide a rich ground for a longstanding future collaboration.

PubliCo has also joined the WHO Public Health Emergency Ethics Preparedness and Response Network, hosted by the Global Health Ethics Unit at the World Health Organization (Dr. Andreas Reis). Involvement in this network enables further fruitful exchange with ethics and communication experts at the WHO regarding standards for good crisis communication and the role initiatives such as PubliCo could play. [35]

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