Mapping in harmony: Co-designing user interfaces for conflict management on OSM

Youjin Choe [a,*], Senuri Wijenayake [b], Martin Tomko [a], Mohsen Kalantari [c]

[a] *The University of Melbourne, Parkville 3010, Australia*
[b] *RMIT University, Melbourne 3000, Australia*
[c] *The University of New South Wales, Sydney 2052, Australia*

ABSTRACT

Online peer-production communities (OPPCs) have witnessed producer conflicts that negatively impact their project quality and producer morale. In response to such issues, OPPCs have supported producers to self-manage conflict as its frequency is exceeding the capacity of volunteer moderators. In this paper, we solicit design guidelines reflecting producers' requirements and perspectives for self-conflict management in an OPPC called OpenStreetMap (OSM). We use the OSM Changeset Discussions user interface – one of OSM's tools designed to facilitate conflict management – as our target interface. We conduct co-design workshops to collect OSM mappers' perspectives on the existing conflict management user interface (UI) and re-design alternatives based on mappers' suggestions. We collect rich reflections on four design prompts covering the User Experience (UX) criteria of utility, usability, desirability, and adoptability, contrasting the current and alternative Changeset Discussion UI designs. Our results lead to two design guidelines: (1) provide gentle and non-intrusive reminders customized based on OSM's mapper profile and (2) provide customizable mapper profile information displayed during online discussion. We discuss challenges associated with the co-designing process in an OPPC as OSM and how future studies should focus on making incremental changes based on user-participatory methods to minimize any user resistance.

1. Introduction

OpenStreetMap (OSM) is an online peer-production community (OPPC) that creates a global geospatial database that captures anything that can be put on an online map, from road segments to buildings. What is distinctive about such content is OSM's origin story, which is about creating geospatial data based on local knowledge. OSM attracted members to join and map their neighborhoods (e.g., creating a building outline or a road segment), hoping that such a localized and decentralized approach could overcome the shortfalls of authoritative geospatial data that could take a long time to be updated.

Ever since its initial launch in 2008, OSM has grown and gained popularity with its open nature allowing anyone to make edits anywhere. This has resulted in mappers making map edits in areas that are not their neighborhoods. When an OSM mapper (i.e., OSM members who make map edits on OSM) makes map edits within a geographic boundary (or what is called a *changeset* in OSM), it reflects a semantic and thematic understanding of that mapper on a real-world feature that they mapped on OSM. Such semantic and thematic understanding is shaped by multiple factors, including geographic location, gender, level of expertise, and professional affiliation (Lin, 2011). Consequently, the increasing diversity of mappers in OSM due to the community growth led to more frequent disagreements between mappers over map edits (hereby called *interpersonal conflicts in OSM*), based on those factors (Choe et al., 2023a). For example, some mappers have interpersonal conflicts on how a road segment should be drawn and how they should be tagged (for example, residential streets or hiking trails). Managing such conflicts on a changeset is a fundamental task in OSM's operation as changesets are constantly edited and updated to keep OSM data current (OpenStreetMap, 2021b). Previous studies have shown negative effects of such interpersonal conflict in OSM such as damaged data quality, low morale of mappers to continue their contribution, and difficulty in building community consensus (Truong et al., 2020; Choe et al., 2023a).

To this end, OSM introduced a user interface (UI) feature called *Changeset Discussion* in 2014 as a communication channel where mappers can discuss changeset edits (OpenStreetMap, 2021b). OSM Changeset Discussion has a simple design: a text box where mappers can

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* Corresponding author.
E-mail addresses: ychoe@student.unimelb.edu.au (Y. Choe), senuri.wijenayake@rmit.edu.au (S. Wijenayake), tomkom@unimelb.edu.au (M. Tomko), mohsen.kalantari@unsw.edu.au (M. Kalantari).

Fig. 1. Current OSM Changeset Discussion user interface (highlighted in orange) extracted from https://www.openstreetmap.org.

write and post their comments (see Fig. 1). It is not a real-time chat, but a channel where mappers subscribe to a Changeset Discussion of their interest to receive notifications whenever a new comment is posted (OpenStreetMap, 2021b). The underlying assumption of such design is that mappers will reach an agreement on a task-based conflict (i.e., editing a single changeset) through an online discussion (Open-StreetMap, 2021b). However, this assumption and the actual effectiveness of the Changeset Discussion UI as a mapper conflict management tool are not yet assessed.

In this paper, we investigate two questions of *What are the mapper experiences with the current mapper conflict management UI of OSM Changeset Discussion?* and *How can this UI be improved?*. Co-design workshops were conducted with OSM mappers of diverse geographic interest, age, gender, level of experience, and professional affiliation to answer these questions. First, OSM mappers' experiences on the current OSM Changeset Discussion UI were collected to identify their pain points. Then, participants were encouraged to discuss how to improve OSM Changeset Discussion UI, using four alternative UI design prompts that were created based on findings of previous studies (Choe et al., 2023a,b). Our results show that the current Changeset Discussion UI design is not optimal for interpersonal conflict management and that design applications found in other OPPCs may not work in OSM, due to the abovementioned OSM's distinctive situation of the gap between the community's original vision for a localized mapping approach and the community's growth into a diverse user base that goes beyond a localized mapping approach. Based on the findings, we suggest two design guidelines for OSM: (1) provide gentle and non-intrusive reminders customized based on OSM's mapper profile and (2) provide customizable mapper profile information displayed during online discussion. Furthermore, While OSM differs from other OPPCs, as their underlying functionality and the types of conflicts observed remain the same (Arazy et al., 2011, 2013; Wu et al., 2013; Ren and Yan, 2017), there is potential that the implications we base on OSM can be applicable to other OPPCs.

2. Related work

2.1. Interpersonal conflict in OpenStreetMap

OpenStreetMap (OSM) is an OPPC that produces geospatial data around the world with approximately 8.3 million registered mappers who produce approximately 4 million map edits per day as of December 2022 (OpenStreetMap, 2022). It is one of the most frequently used map resources for public and commercial projects (Anderson et al., 2019; Choe et al., 2023a). Such growth of OSM came along with the increase of interpersonal conflict among producers–*mappers*–which have raised concerns about their data quality and member contribution (Russell, 2018; BBC.com, 2019).

OSM mappers have experienced interpersonal conflict over multiple topics: sometimes it is about a map edit itself (e.g., geometric feature, attribute) due to semantic differences (Lin, 2011; Ali et al., 2014; Ballatore and Mooney, 2015; Touya et al., 2017; Choe et al., 2023a). Mappers have conflict over mapping process and methods (e.g., local knowledge versus AI-assisted technique using remote sensing image Choe et al., 2023a) and community norms (Choe et al., 2023a). Such conflicts in OSM occur due to the fragmentation of the OSM community by diverse subgroups whose boundaries include gender, geographic location of mappers, level of expertise, and professional affiliations (Lin, 2011; Choe et al., 2023a). Fragmentation of OSM community due to diversity of subgroups within also reflects differences among OSM users' view on what OSM is and what the community is providing from critical perspectives: values of privacy and anonymity of mappers versus revealing mapper information (e.g., geographic location, gender, affiliation) for data quality assessment (Jaljolie et al., 2023). Making data available in Global South using AI-assisted mapping techniques by commercial mappers versus viewing such process as colonizing by local mappers (Schröder-Bergen et al., 2022). Each subgroup has clashing interests with other subgroups, creating disagreements during the geospatial co-production process or *interpersonal conflict* (Choe et al., 2023a). Uncooperative and negative behaviors often aggravate the interpersonal conflict in OSM (Choe et al., 2023a,b). Such conflicts have been reported to have mostly negative effects on mappers' morale, retention rate, and community consensus (Choe et al., 2023a).

Interpersonal conflicts found in OSM share similarities to other OPPCs in terms of underlying causes and possible effects. For example, editors in Wikipedia have experienced edit wars due to interpersonal conflict between editors with diverse backgrounds that have been triggered by opinions expressed about their gender, depth of knowledge and experience (Yasseri et al., 2012; Filippova and Cho, 2015; Singh, 2019). Similar to OSM, the conflicts Wikipedia witnessed impacted the project negatively, affecting editors' willingness to further participate in the community and contribute in the future (Filippova and Cho, 2015; Quattrone et al., 2014; Menking and Erickson, 2015; Chhabra et al., 2020). A salient difference between Wikipedia and OSM is that
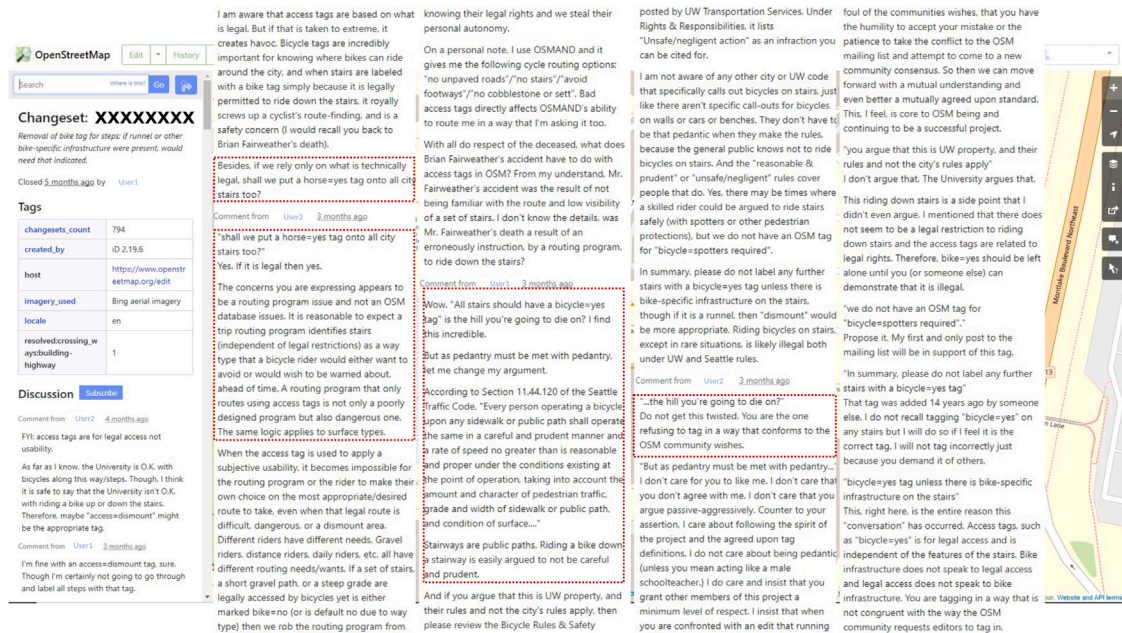
Fig. 2. Example of interpersonal conflict in OSM extracted from https://www.openstreetmap.org.

the peer-produced product in OSM is a (semi-structured) geospatial dataset. The data quality of this dataset is compared with authoritative geospatial data (i.e., created by the national mapping agencies) based on geospatial data quality standards such as the International Standard Organization's document (Girres and Touya, 2010; Mooney et al., 2010; Touya et al., 2017; Chittor et al., 2022). Interpersonal conflicts in OSM are often inherently grounded in different understandings of the relationship between the geographic environment and the loose and underspecified definitions of the features that can be mapped (Choe et al., 2023a). Our research contributes to the literature on OSM conflict, departing from the focus on the *product*, but rather assessing interpersonal conflict *management*. We seek to understand the *behaviors* manifesting in online interactions, their triggers, and the means to manage them. Such research is of importance beyond OSM — other OPPCS experience similar conflict dynamics, particularly in contexts where the interaction is mediated via interfaces that have not been designed to support interpersonal communication dynamics adequately (Arazy et al., 2013; Wu et al., 2014). Despite the different products OPPCs create, they share similar characteristics of conflict and management approaches (Choe et al., 2023a,b).

OSM Changeset Discussion is where such interpersonal conflict in OSM frequently manifests during the geospatial data co-production process (Choe et al., 2023a,b). Fig. 2 captures an example of interpersonal conflict in OSM in red-dotted boxes. Initial conflict occurs when the mapper who created the changeset disagrees with a piece of information made by another user and ends the comment with a sentence that could be read as sarcastic. The conflict is escalated as both mappers engage in their discussion with sarcastic and non-negotiating tones. The discussion becomes lengthy and as these users make changes according to their arguments back and forth, the details of the map are affected back and forth.

Previous studies have suggested design implications on OSM Changeset Discussion UI to improve its conflict management functionality (Choe et al., 2023a,b). The first implication is to improve procedural clarity by providing step-by-step guidelines on how to map (or collaborate with other mappers), where content could be customized for each subgroup (Choe et al., 2023a). Another implication is regarding mappers' online behaviors, in particular, encouraging positive and forward-looking behaviors and discouraging negative ones (Choe et al., 2023a,b).

These design implications on OSM Changeset Discussion UI are well aligned with OSM's Code of Conduct (i.e., OSM Etiquette Guidelines) (Choe et al., 2023a,b). However, they are at a high level where specific design guidelines for the UI are not yet identified. Nor are they fully integrated into the current OSM Changeset Discussion UI, thereby not harnessing the UI's full potential to encourage certain mapper behaviors for interpersonal conflict management. Using these design implications set forth by the prior work as the foundation, we turn to UIs of other OPPCs who have been comparatively successful in conflict management for inspiration.

2.2. Conflict management design implications in online peer production communities

Procedural clarity. Procedural clarity as a design implication in OSM involves providing clear step-by-step guidelines on how to interact with other mappers (Choe et al., 2023a). Providing clarity in information and instruction in online communities could be done through providing reminders, notifications, and options that are easily accessible by users (Naqshbandi, 2023). An example of incorporating the design implications on procedural clarity can be found in StackOverflow. As a question-and-answer OPPC where its members collaborate to create a solution and to manage any disagreements in the due process, it shares similarities with the functionality of the OSM's approach to online peer production and interpersonal conflict management. As shown in Fig. 3 in orange dotted boxes, the interface is designed to help users to post a question on a forum with *embedded texts* below each item. It provides guidelines and steps to take in order to post a question. It first asks the users to summarize the problems they have, describe what they have tried to address the problems and share the code that they created. This clear 3-step approach helps the users post a question with clarity and the other users to have a context and offer help efficiently.

Another example is found in a Stack Exchange community where members are prompted with a pop-up window containing three steps to follow when writing a *good* question (Fig. 4). These UI design components provide members with clear steps to take in order to undertake activities within their communities, reducing potential mistakes and confusion and leading to less interpersonal conflict.
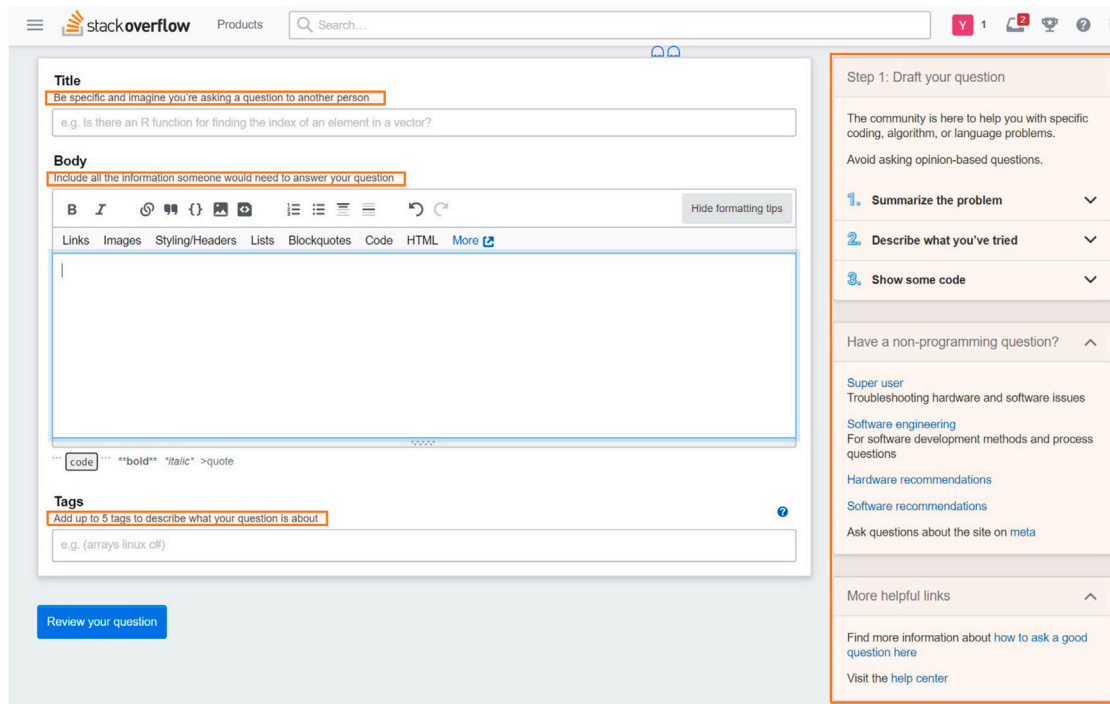
Fig. 3. Example of improving procedural clarity through embedded text in Stack Overflow highlighted in orange (https://www.stackoverflow.com).
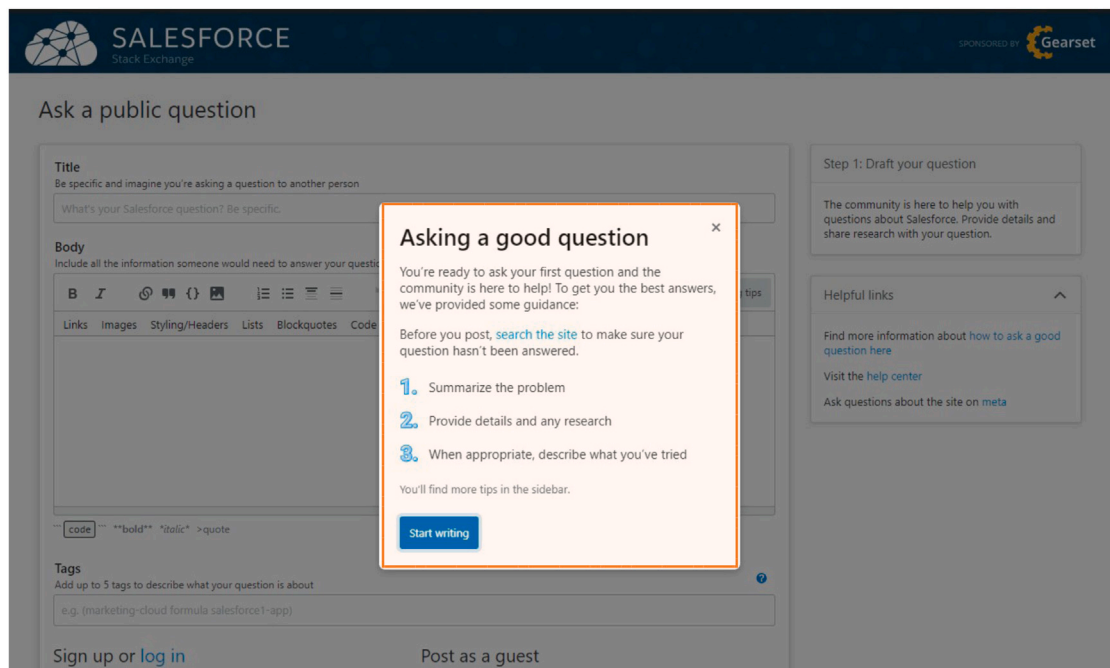

Fig. 4. Example of improving procedural clarity through a pop-up box highlighted in orange (https://www.stackexchange.com/).

Online behaviors. Online behaviors as a design implication in OSM is regarding encouraging desired online user behaviors and discouraging undesired ones, for example, be polite versus do not attack the other users (Choe et al., 2023a,b). Wikipedia's talk page shows how the design implication on expected online behaviors in OPPCs could be incorporated as part of online discussion UI design. Fig. 5 shows a screenshot of a Wikipedia talk page with a default table and embedded text from their code of conduct as a reminder on how to interact with other contributors. A code of conduct is often available as a separate web page in online communities for producers to refer to, often resembling a manifesto. In online communities, the code of conduct (or its equivalents) is a type of social contract that lists expected and unacceptable online behaviors (Li et al., 2021) that members of a community are voluntarily committing to adhere to. One common trait is the *good citizen approach* that the code of conduct is based on. The good citizen approach is – loosely – defined as a social strategy that relies on the voluntary compliance of social group members to the community rules and regulations. When a group does not have legally binding member contracts, the good citizen approach offers an alternative option to establish a common participation platform

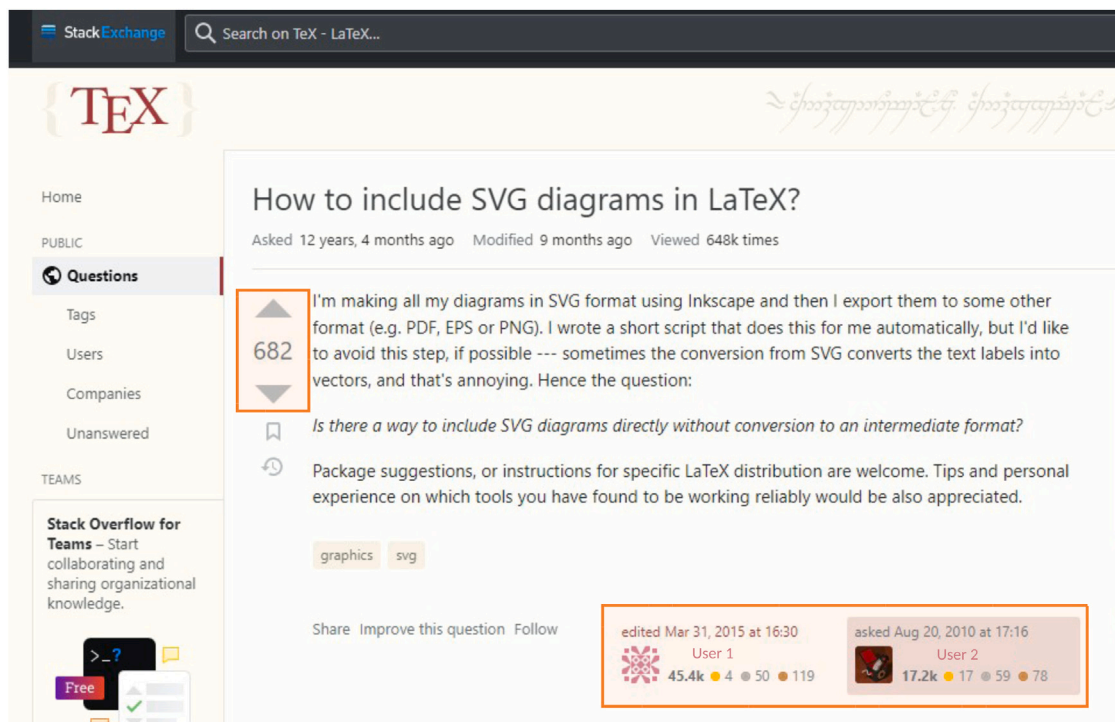**Fig. 5.** Example of improving online behavior through embedded texts in highlighted in orange (https://https://en.wikipedia.org/wiki/Talk:Wiki).

Fig. 6. Example of improving online behavior through comment voting and visible user profile in highlighted in orange (https://www.stackexchange.com/).

for members (Villalobos et al., 2021). However, by making the code of conduct part of the online discussion UI, the community could encourage producers to actively avoid unacceptable behaviors and thus minimize unnecessary conflict involving personal attacks, profanity, or negative emotions.

Moreover, Stack Exchange uses comment voting as a UI design to encourage expected online behaviors that could manage interpersonal conflict during online discussions. As shown in Fig. 6, users of a community at Stack Exchange could vote up a comment that contains the best solution to their conflict. Such community voting, or rating of any kind, could support interpersonal conflict management and community consensus building through a member-participatory method (Danescu-Niculescu-Mizil et al., 2009; Glenski et al., 2017). These are various formats of reputation systems that are designed to enable members to simply and effectively express their perception of others, or their contributions (Danescu-Niculescu-Mizil et al., 2009; Glenski et al., 2017). They bring an element of gamification into community contributions, thus encouraging continued participation via the writing of good questions, articles, or answering questions according to the code of conduct (Bista et al., 2012). Reputation systems support

producer conflict (self-)management in line with the code of conduct and community discussion guidelines. They encourage producers to adhere to expected behaviors and reinforce their sense of belonging to the community.

Another useful design component displayed in Fig. 6 is the visible user profile that contains the user's profile photos and information on users' contributions. Such visible user profile improves online social presence, which increases conformity to positive group norms during discussions, thus reducing the likelihood of online conflict (Wijenayake et al., 2020) as well as enhancing trust within the community (Hassanein and Head, 2004; Venkatanathan et al., 2014). This also reflects users' identity which could be used as a proxy indicator to assess users' motivation to participate and willingness for long-term engagement in online communities (Naqshbandi, 2023). Prior work shows that with visible user profiles the discussant's behaviors were more aligned with widely accepted social norms (e.g., being nice/polite to each other) (Wijenayake et al., 2020) and welcoming (Hassanein and Head, 2004; Venkatanathan et al., 2014), similar to the expected behaviors listed in OPPCs codes of conduct.

From the two design implications of procedural clarity and online behavior, we identified four recurring design components of (1) embedded text, (2) pop-up window, (3) rating/voting, and (4) visible user profiles that are used in other OPPCs as mediums to encourage expected user behaviors of online conflict management. As far as our knowledge goes, these design components in other OPPCs have not been assessed with actual users. We use these findings from previous literature and cases of other OPPCs as the foundation to answer our research questions.

3. Methodology

Acknowledging the gap from the previous literature and the importance of involving users in improving their experiences, we intend to assess the current UI of conflict management in OSM and how it can be improved based on feedback of OSM members who used the UI. We conduct co-design workshops with those OSM members to collect their opinions on the current UI of OSM Changeset Discussion and co-design possible alternative UIs through the four design components identified from Section 2.2 (i.e., embedded text, pop-up window, rating/voting, visible user profiles).

3.1. Co-design workshop method

There are multiple research methods available to study user experience. Diaries and interviews are both advantageous for acquiring an in-depth qualitative understanding of user experiences (Wilson, 2013; Lazar et al., 2017). However, they are limited by their time-consuming process requirements (Wilson, 2013; Lazar et al., 2017). User surveys and user log analyses address these limitations by enabling the administration of a questionnaire to a large number of users, or by directly analyzing online behaviors based on logs of real user activity, respectively (Dumais et al., 2014; Lazar et al., 2017). However, they have shortcomings in the loss of subtle, qualitative nuances that can be acquired from direct observation or by interviewing users (Dumais et al., 2014; Lazar et al., 2017).

A co-design workshop is a participatory method to collect stakeholders' feedback on a topic or product (David et al., 2013). It encourages all stakeholders to participate in in-depth discussions where *"a sense of ownership emerges when the community provides meaningful contributions from the beginning stages of the design process"* (David et al., 2013, p. 9). Additionally, the method provides the flexibility of hosting online discussions among participants from different countries within a relatively short time frame (Kennedy et al., 2021; Zhu et al., 2021). These qualities suit the aim and target community of this study (e.g., discussing a public online communication channel UI with producers in a global OPPC distributed globally).

3.2. Design prompts for co-design workshop

Based on the four design components that were identified in Section 2.2, four design prompts were created, each of which corresponds to each design component of (1) embedded text, (2) pop-up window, (3) comment rating/voting, and (4) visible user profile, which were created by the online UX design website - Miro. These design prompts were used as a tool to start and steer discussions among OSM users during co-design workshops. Each design prompt is made to contain only a small, incremental change from the current design and to provide only a starting point for the co-design workshops (Keen, 1981) as described below.

Embedded text. As identified in Section 2.2, embedded text was used to improve both design implications of procedural clarity and online behaviors. We applied embedded text design component inside the OSM Changeset Discussion as shown in Fig. 7 inside the orange box. We derived three types of text to be embedded, based on the design implications found from previous studies as mentioned in Section 2.2:

- First text type: Encourage cooperative online behaviors by reminding the member of expected and unacceptable behaviors when using Changeset Discussion (e.g., be nice to each other as colleagues who are working on the same goal of improving the OSM database);
- Second text type: Provide quick pointers on how to write a good comment and how to communicate with each other (e.g., be clear and concise); and
- Third text type: Encourage members to focus the discussion on the Changeset in question and to keep the discussion on track (e.g., please stick to the discussion of this Changeset).

Pop-up window. The second design prompt is a pop-up window that appears when the mouse cursor clicks on the Changeset Discussion box (Fig. 8). This pop-up design is similar in functionality to the embedded text design as it too provides members with a textual reminder. The aforementioned three different types of text introduced in the embedded text prompt were also used for the pop-up window prompt.

Comment rating/voting. The third design prompt is comment rating (Fig. 9), in which two particular aspects from other OPPC websites were observed: (1) comment rating is not about the members themselves, but the comments that the members make, e.g., addressing the comments' usefulness or relevance; and (2) the rating can be binary (e.g., thumbs up or down) or on a (linear) numeric scale (e.g., 1 to 5 stars). Participants were asked to discuss which modality may be more suitable for OSM's needs.

Visible user profile. The last design prompt is the exposure of a visible user profile, aimed at improving the online social presence. As shown in Fig. 10, this design reveals much information about the members when they submit a comment, such as their photo, link to their user profile page, affiliation, or geographic areas of interest, which was decided based on the findings from previous studies on OSM's interpersonal conflict management (Lin, 2011; Choe et al., 2023a). Similar to the approach to the comment rating design, the participants were asked to discuss what type of information should be made visible.

3.3. Recruitment of participants

The co-design workshop design was approved by the Ethics Committee of the university.[1] Participation in this study was voluntary and without any monetary incentives.

The recruitment process was three-fold. First, interest in conducting such a co-design workshop and an appropriate way to announce the call for participation was gauged by reaching out to the OSM Science mailing list in early June 2022. Next, based on the recommendation received from the mailing list, an OSM user wiki page[2] was created in mid-June, describing the overview of the study and inviting OSM mappers' participation in the co-design workshop. On this user wiki page, we called for participation of (1) those OSM members who volunteered in moderating and facilitating user discussion on OSM Changeset Discussion feature; (2) those OSM members who volunteered in developing tools and features in OSM; and/or (3) those OSM members who have collaborated in OSM in the last 7 years (both long-term members and newcomers). Then the URL of the wiki page was shared through relevant social media channels to the OSM community (e.g., Twitter, Slack) for a broader distribution from mid-June 2022 for 2 months and amplified the call by reaching influential members of the OSM community with contacts amongst the OSM community, to gain broader diversity of participants.

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[1] Ethics approval was granted by Engineering Human Ethics Advisory Group, University of Melbourne (Ethics ID: 2022-24181-28180-2).
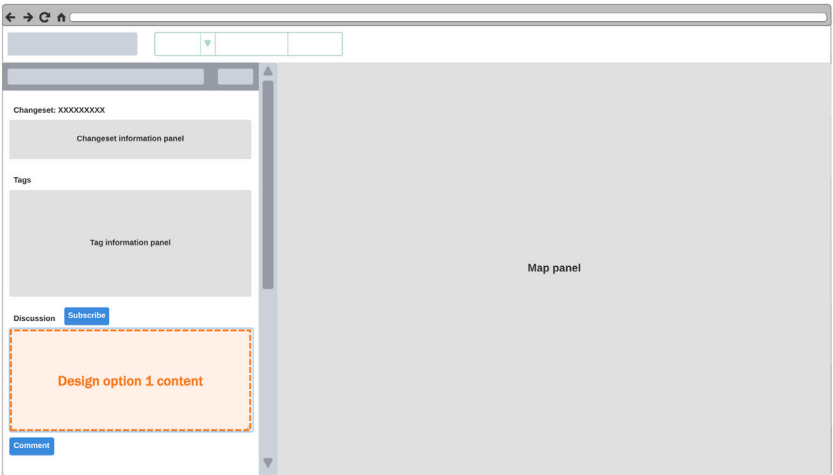[2] https://wiki.openstreetmap.org/wiki/User:Eugenia.
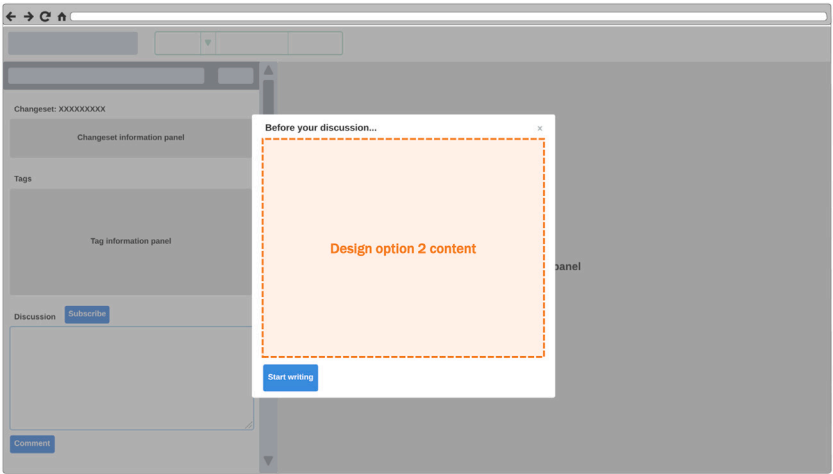
Fig. 7. Prompt 1 - Embedded text.

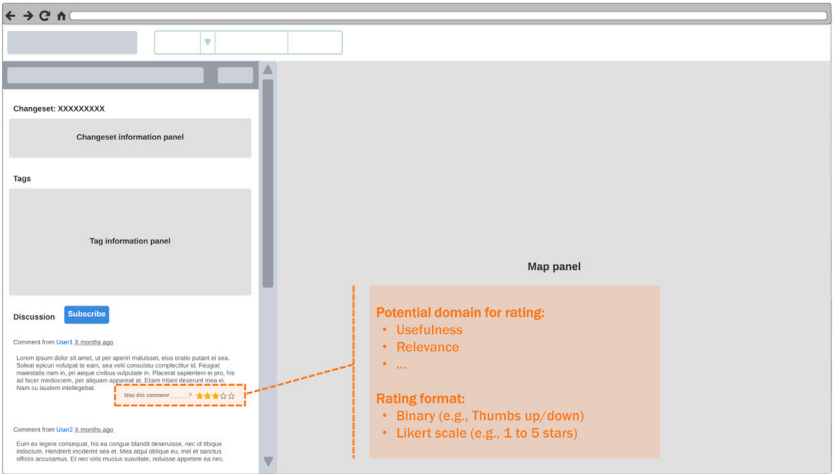**Fig. 8.** Prompt 2 - Pop-up window.

Fig. 9. Prompt 3 - Comment rating.

Once the potential candidates contacted the corresponding author, they were provided with two options of email or teleconference meeting for more information about the study. The corresponding author explained the aim, background, and process of the study to each potential candidate based on their preferred communication method

before they decided to join the user workshop. 15 participants were recruited whose gender, geographic locations, length of community membership, and key roles in the community vary.

Having all 15 participants in a single group would limit the time available to each participant to share their opinions. Some participants
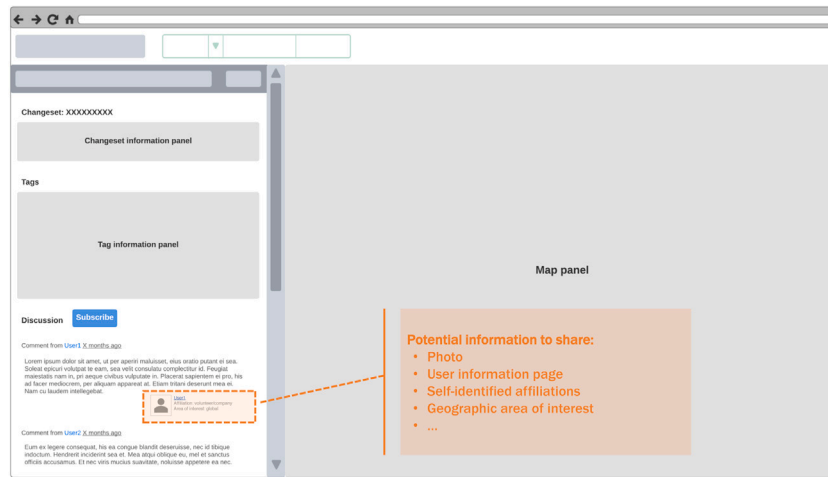
Fig. 10. Prompt 4: visible user profile.

Table 1
Summary of co-design workshop participants.

	Number of participants
By affiliations	
Volunteer and/or other affiliations	13
Volunteer	*5*
Volunteer and more[a]	*8*
Employee of a corporate OSM user	1
Employee of a NGO	1
By roles within OSM	
Mapper and/or other roles	14
Mapper	*8*
Mapper and more[b]	*6*
Developer	1
By length of membership	
Less than 10 years	9
More than 10 years	6
By geographic regions of interest	
Asia	3
Africa	1
Europe	2
North America	2
South America	1
Oceania	1
Global[b]	5
By gender	
Woman	3
Man	8
Transgender Woman	1
Non-Binary	1
Agender/I don't identify with any gender	1
Total	15

[a] More affiliations include OSM administrative member, an employee of a corporate OSM partner/NGO, academic.
[b] More roles include developer, moderator, and community organizer.
[c] Participants declaring more than two geographic regions of activity were recorded as global.

may not feel comfortable sharing their opinions in large groups. After reviewing the literature about the format of co-design workshops and the number of participants (David et al., 2013; Kennedy et al., 2021; Zhu et al., 2021), the participants were divided into four groups of three to four participants from similar time zones. As shown in Table 1, the participants' backgrounds are diverse in terms of their gender, geographic areas of interest, role within OSM, and professional affiliations. This is to reflect various boundaries of OSM subgroups that were identified in Section 2. Including participants with diverse roles (i.e., developers, moderators, and community organizers) can improve

the ownership of the problem and the OSM Changeset Discussion UI through the co-design workshop process (David et al., 2013).

3.4. Co-design workshop process

Depending on the purpose, a co-design workshop may often consist of multiple sessions repeated among the same group of participants, to ensure the collection of diverse, and evolving opinions (Kennedy et al., 2021; Zhu et al., 2021). A two-round co-design workshop discussion was designed for each group for this study. The first round was designed to (1) collect the participants' opinions about the pain points of the current OSM Changeset Discussion UI, addressing the first research question (*what are the mapper experiences with the current mapper conflict management UI of OSM Changeset Discussion?*) and (2) encourage discussion among the participants on improving the current UI for better online interpersonal conflict management, addressing the second research question (*how can this UI be improved?*), based on the four design prompts in Section 3.2. All four prompts were improved based on user feedback from the first round of discussions. Then, the second round was designed to further the discussion on the four design prompts and potential suggestions on OSM Changeset Discussion UI.

The corresponding author took the primary moderator role of facilitating the discussion and making sure that every participant shared opinions in the group session. One of the co-authors took the secondary moderator role, following the discussion, observing the group dynamics, and occasionally asking supplementary questions. Each session lasted for one hour, including the introduction, discussion, and final wrap-up, and was recorded via the Zoom online teleconference system, manually transcribed, and annotated by the corresponding author. When transcribing audio recordings of the co-design workshop, all participants' names were randomly anonymized, using letter designations (e.g., P1, P2).

Before the first-round session. The participants were provided with the wireframes described in Section 3.2 (See Figs. 7 through 10) via email one week before the first-round session to provide them enough time to reflect on their experience of being involved in and managing interpersonal conflict in OSM using the Changeset Discussion. They were asked to be prepared for the first-round discussion and share their opinions about the current OSM Changeset Discussion UI and the four design prompts based on three assessment criteria:

- Utility: How well do you think each prompt is designed to help you with online interpersonal conflict management in OSM?
- Usability: How easy would it be to use each prompt for self-management of interpersonal conflict in OSM?

- Adoptability: How easy would it be to implement each prompt from the platform's perspective? How easy would it be to accept each prompt from the member's perspective?

Utility and usability are fundamental dimensions to consider when designing and implementing any system or interface that involves online interaction (Grudin, 1992). The utility is about the function that a UI is intended to deliver (Grudin, 1992; Hudspith, 1997), while usability is about the level of ease of use of the UI for the intended users which includes aspects such as how easy to find the function (i.e., discoverability), how easy to learn and memorize the function (i.e., learnability and memorability) (Hornbæk, 2006; Bevan, 2009). Additionally, adoptability is considered as a measure assessing the ease of *implementing* the UI from the platform's perspective, and the ease with which the UI is *accepted* by the users (McGrath, 2005; Mourouzis et al., 2005). Adding adoptability as part of the criteria can support understanding how realistic each design prompt is for its actual implementation and how much user resistance there could be.

During the first-round session. The primary moderator welcomed the participants of the group, followed by an explanation of the research problem, research question, and the structure of the session. Participants took an ice-breaking session before starting the discussion, introducing their backgrounds and activities in OSM. A semi-structured discussion was facilitated by the primary moderator based on the three assessment criteria on the current OSM Changeset Discussion UI and four design prompts as presented in the order they appear in Section 3.2. For each design prompt, the primary moderator asked three identical questions, each of which corresponds to the assessment criterion:

- As an OSM user, what is your opinion about the suggested design prompt? How can it be improved for conflict management in OSM?
    - Utility: the design prompt's ability to manage conflict based on its visual features and intended functions
    - Usability: easiness of the design prompt to support OSM users to manage conflict (e.g., learnability, efficiency, memorability, error prevention, satisfaction)
    - Adoptability: the design prompt's practicality to be implemented in OSM and to be accepted by the users

The participants answered the questions and suggested design changes to the prompts verbally. Upon the wrap-up of the discussion, the primary moderator summarized the discussion and scheduled the second-round session with the participants. Depending on the group, the second-round discussion was scheduled one or two weeks after the first-round session.

After the first-round session/before the second-round session. Each design prompt was improved based on the participant feedback from the first-round session. The primary moderator sent the updated prompts to the participants a few days before their second session, which is discussed under Section 4. The participants were asked again to be prepared to share their opinions about each updated prompt against the design criteria.

During the second-round session. The primary moderator welcomed the participants of the group, followed by explaining the structure of the second-round discussion. The participants were asked to discuss the improved design prompts based on the assessment criteria.

After the discussion, the participants voted on which design (including current UI design and four design prompts) has the highest perceived utility, usability, and adoptability, using the real-time online polling website called PollEverywhere. The participants were given one vote to select a single design prompt per criterion. This was to collect the OSM members' opinions about their strongest preference out of the four design prompts, against each assessment criterion (see Fig. 11).

At the end of the second-round discussion, participants voted for each design prompt based on utility, usability, and adoptability (see Section 3.4), using a real-time online voting tool. The poll was designed in such as way to identify the participants' preference for each prompt against each assessment criterion, as each design prompt is not mutually exclusive (i.e., some design prompts can be combined into a single UI).

3.5. Analysis of co-design workshop

The text transcriptions of the video recordings were analyzed, using the constant comparison analysis method. This method is commonly used for analyzing discussions on the same topic by multiple groups (Onwuegbuzie et al., 2009). It has also been used previously for gathering users' opinions about interfaces or systems to improve their visual appearance and functionality (da Silva Melo et al., 2022; Porcaro et al., 2022). The participants' feedback and the in-depth discussions on each design prompt were collected and analyzed as follows:

- Stage 1: Identifying codes (i.e., unique descriptive keywords) for each participant's opinion about the design prompt;
- Stage 2: Grouping the codes by assessment criteria for each design prompt; and
- Stage 3: Select an emerging theme for each design prompt for each assessment criterion.

Once the themes for each group were identified, cross-group themes were assessed for each design prompt and each assessment criterion (Stage 4 in Fig. 12). This process identified common themes arising in the individual group discussions for all of the design prompts, and their utility, usability, and adoptability in OSM. Out of total four authors of this paper, three of them were involved in the analysis process.

For example, during stage 1 of analyzing discussion on the status quo design, the keywords/phrases such as *small space*, *too simple design*, and *difficult to follow up when discussion becomes lengthy*, *confusing to use for new comers*, *not safe to dive-in without reference point*, and *not safe/comfortable to dive-in without cultural context and/or background* were identified. These identified codes were then categorized into relevant assessment criterion in stage 2 of the analysis: *small space* and *too simple design* was categorized into utility and the remaining items under usability. During stage 3 of the analysis, one theme of *functional, but not optimal design for conflict management* emerged for utility of the status quo, and two themes for its usability, which were *not easy to use for lengthy discussion* and *not safe to participate without enough expertise/experience and/or cultural background*. During the last stage of cross-group theme selection, all themes were selected, as they were across the groups.

During the analysis process, some participants' comments were identified on anticipated members' level of engagement with each UI design concerning online interpersonal conflict management. These comments are closely connected to utility, usability, and adoptability but cannot be categorized into any single specific criterion. These comments were often related to how much the UI is visually attractive and enjoyable, aspects that align with recent user experience models (Mahlke and Thüring, 2007; Kujala et al., 2011). Hence, the fourth criterion–*desirability* was included:

- Desirability: How engaging do you think each design prompt is for online interpersonal conflict management in OSM?

4. Results

This section presents study results for each design prompt, starting with the current OSM Changeset Discussion interface design. Themes that have emerged throughout all groups are discussed first, followed by those that have emerged more rarely in groups. As each group

Fig. 11. Real-time polling done by the participants in clockwise-order.
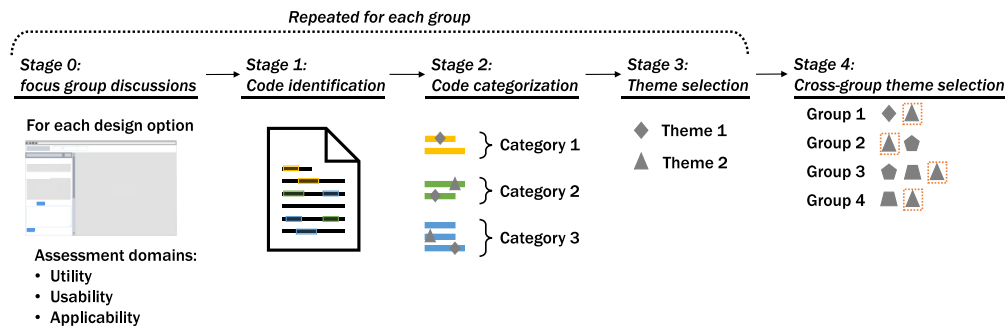

Fig. 12. Co-design workshop data analysis process.

consists of participants from diverse backgrounds (Section 3.3), discussing themes that have reached saturation across groups versus those that have not provides an in-depth understanding of shared attitudes, in contrast to opinions that may be more specific to individuals or mappers with a particular lived experience. Saturation of the themes was decided based on (1) the theme being mentioned more than twice by all the groups and/or (2) the length of the discussion of the theme being longer than half of the allocated time (out of 1.25-h workshop), 15 min was used for introduction, icebreaking, wrap-up, and 1 h was distributed evenly for each design prompt (i.e., 15 min per prompt) and for each design assessment criterion (5 min per criterion). Figs. 13 through 18 show the design prompts that were improved after the first-round session based on the participants' feedback, which changes are described in orange boxes within each Figure.

4.1. Current OSM changeset discussion design

Utility. All the participants mentioned that the current UI design of the OSM Changeset Discussion is not optimal. This design is perceived to be only functional. It is also easy to miss new comments, which leads to new mapper conflicts; *"I remember one time I made a change [...] and someone commented, but I didn't see it until three months later when my changeset was reverted [...] and the person said that [...] you didn't reply to my comment" (P8)*.

More than half of the participants mentioned or agreed on the **cultural differences** in interacting with other mappers as a factor that lowers the utility of the current design. Participants noted that some cultures perceive private communication channels (i.e., via email or a direct message on OSM) to be more appropriate until the discussion is ready to be shared on OSM Changeset Discussion. Some participants mentioned that they do not use OSM Changeset Discussions currently due to their **personal preference** towards other communication channels (e.g., Whatsapp, Telegram, Discord, Slack) since it supports mapper discussion and conflict management with better functionality and aesthetic (which is linked to the desirability of the current UI design).

Usability. For short discussions, the simplicity of the current design can be an efficient communication channel enabling the mappers to
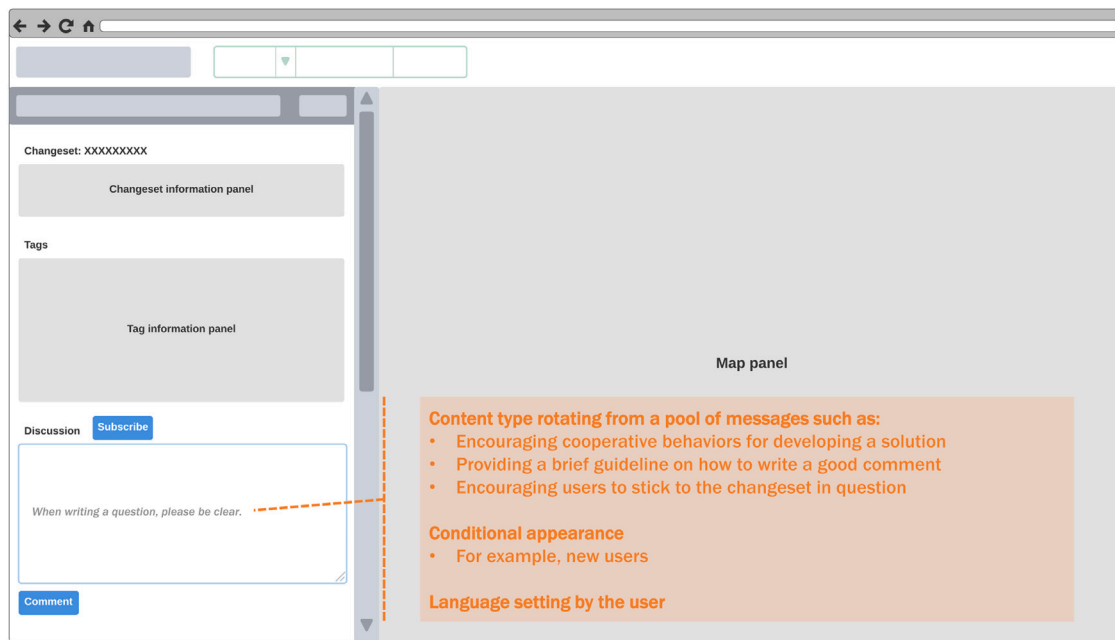
Fig. 13. Suggestions to improve embedded text prompt.

manage conflict. Once the discussion becomes long and complicated, which may happen depending on the **complexity of the discussion topic**, its utility is reduced as it becomes difficult to follow all arguments. It becomes difficult to separate mappers who created the Changeset from those who comment and to remember who suggested what.

Adoptability. Participants mentioned that this UI must have been implemented due to its **technical simplicity** to adapt to the platform. Participants also mentioned that some mappers are using the current UI because it is recommended, but other mappers do not use it because (1) they do not know it exists (linking to the current design's poor utility and usability) or (2) they do not know how to use properly (linking to the low desirability of the current design).

Desirability. All the participants agreed that the current UI design is *"not exactly the prettiest interface"* and not engaging members as the design is *"very technical"* and *"static"*. Its **simple and static design hinders mapper conflict management in extended discussions**, which affects the utility and usability. All participants agreed that new mappers may not feel safe using the Changeset discussion feature because it is **not well promoted** throughout the community. Some participants mentioned that they *"do not want to use"* this function, because they either do not know what OSM Changeset Discussion is *for*, or they do not feel *"comfortable"* using it.

4.2. Embedded text design

Utility. All participants mentioned or agreed that the embedded text design could be **helpful for new mappers** to understand (1) what an OSM Changeset Discussion is *for* and (2) what are the *expected* behaviors in a Changeset discussion thread, thereby improving procedural clarity and promoting prosocial online behaviors as recommended by prior work (Choe et al., 2023a,b). They also agreed that the embedded text design will function as an **unobtrusive reminder** for both new and established OSM mappers, depending on the type of content displayed. For example, participants suggested that for new mappers, the message may introduce a *how-to* of the Changeset Discussion, whereas for long-term mappers it could encourage them/remind them to be nice and civil when commenting, or to compliment good edits.

Usability. Some participants mentioned the **simple design and functionality** of the embedded text design as a plus for memorability,

learnability, error prevention, and safety, but may be too easy to use that it is *"ignorable"*, especially for long-term mappers. Other participants questioned the design's efficiency and whether it will help the mappers to keep the discussion short and succinct to manage potential mapper conflict emerging.

Desirability. All participants agreed that the embedded text design may have a certain level of desirability as it is incrementally **more engaging** than the current, but **less intrusive** than other prompts. However, they also argued that this may also be a shortcoming of this design's usability and mappers may not change their behavior, thus reducing the impact on the management of mapper conflict.

Adoptability. The majority of participants across all four groups agreed on the **easy adoptability** of this prompt in terms of its technical requirements and mapper acceptance, as it is the simplest design prompt among the four proposals. Nevertheless, participants raised **concerns about who will decide what to put as the message of the embedded text**, as different mappers may have different opinions about what should be included.

Improvements. Participants suggested that the design could be improved if the embedded text was clear and contained specific behaviors which could be helpful to *"new users that are getting to learn the community for the first time"* (P1; P3; P6; P8; P10; P14; P15). Examples of suggestions made by the participants are shown in Fig. 13. Rotating the selection of this text from a pool of alternative messages may better engage mappers, although there were realistic concerns on having somebody responsible for adding a new message and who is going to decide what messages those are. They also mentioned that this design should be available in multiple languages or the language matching the language setting preference of the mapper. Some participants suggested more formatting of the Changeset Discussion text box itself, such as (1) a separate box for sharing relevant URLs or a discussion history browser that could support understanding context and (2) different colors for highlighting user IDs that created the Changeset for better readability of the discussion flow.

4.3. Pop-up window design

Utility. All 15 participants either commented or agreed that the pop-up window design can be **helpful for new mappers** being introduced to the OSM Changeset Discussion. Some participants mentioned the
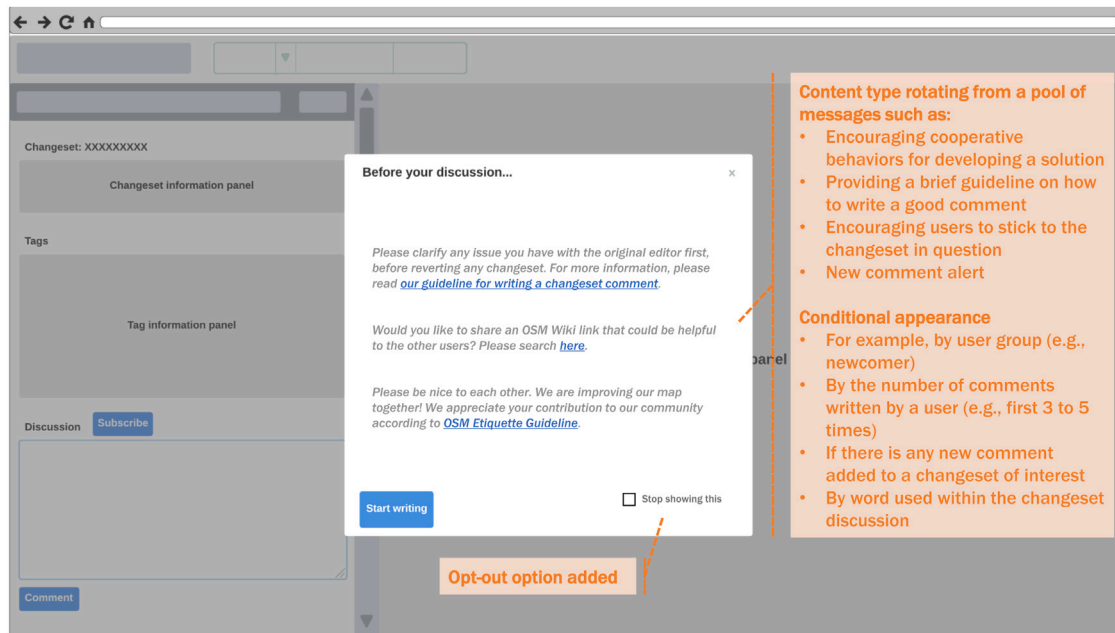
Fig. 14. Suggestions to improve pop-up window prompt.

'eye-catching' nature of this design which could function as an **occasional reminder** and even *"help users to think twice before writing any comments"* (P8). However, they also agreed that this **design may be handicapped** if the mappers install a browser pop-up blocker or if they close down the pop-up window without reading its contents.

Usability. Overall, participants questioned the usability of the pop-up window for easy online interpersonal conflict management. They mentioned possible **difficulties in memorizing or learning the contents of the pop-up window**, depending on the length of the message in question. Similar to the embedded text design, the efficiency of the pop-up window design may or may not be improved, depending on how much mappers change their behaviors according to the messages delivered via the pop-up window. Participants pointed out that although it provides a sense of safety to new mappers and may help them with error prevention, the pop-up window is **not an aesthetically satisfying solution** (see desirability, below).

Desirability. Among all four design prompts, the pop-up window was the only one that received **consistent negative feedback regarding its desirability**. The most common comment was that the design would be *"annoying"* and *"disrupting"* rather than engaging if shown every time the OSM Changeset Discussion textbox was activated. Some participants described the feature as **intrusive** and that they *"do not want some messages to tell me what to do, disregarding years of experience"* (P2; P12).

Adoptability. The technical adoptability of the pop-up window design was positively appraised. However, all participants either mentioned or agreed that this design may not be accepted by the diverse OSM mapper base due to the **variable user pop-up settings**.

Improvements. Participants suggested customizing the pop-up window's contents and its appearance. For example, if a mapper appears to be relatively new or never used the OSM Changeset comment window before, then a quick guide on how to use it could pop up. Similar to the embedded text design, the messages could be made shorter and provided in multiple languages with localized content. Participants also suggested an opt-out option for mappers who would like to *"avoid the pop-up window"* after its first appearance (see Fig. 14). As a remediation of the disappeared message in the pop-up window, some participants suggested adding a small question mark on top of the Changeset Discussion text box that would contain the same set of information, retrievable on demand. Some participants' suggestions included a small

pop-up text box that would appear when members write sentences that are not aligned with expected behaviors.

4.4. Comment rating design

Utility. While some participants commented that the comment rating design could at times be functional (with reservations, such as *"binary format will work better than 5-star rating scale".*), all participants agreed on the **net negative utility** of comment rating design. They commented how it could be used to *"dog-pile"* over *"minority views or to shame users for making mistakes"* (P1; P2; P4; P6), which was likely to discourage discussion and escalate mapper conflict in OSM. Some participants shared their **concerns on the misuse of the function**, as people may *"shift their focus on comments, rather than the edits of the Changeset in question"* (P10), leading to further escalation of mapper conflict. Due to such negative utility, participants even mentioned that they do not see the comment rating design to be appropriate for mapper conflict management at all.

Usability. Negative comments prevailed also concerning the usability of the comment rating design. All participants either agreed or commented on how **choosing a criterion to rate on will be *"misleading"*** for the mappers, negatively affecting memorability and learnability. They mentioned that new mappers may in particular *"not feel safe"* to use the UI. While some participants mentioned that the error prevention of this design would be better than that of other designs if the rating could be undone by the original rater.

Desirability. Interestingly, participants agreed that this design **could attract more attention of OSM mappers to contribute more** if the design was improved for utility and usability. Some participants said that while the comment rating design may lead to *"competition between sub-groups of users"*, it could also be a good tool for *"community moderation"*.

Adoptability. Participants agreed that the comment rating prompt should not be difficult to apply in the OSM environment. However, they were **concerned about mapper acceptance**. Some mentioned that *"it ends up with DWG members [Data Working Group members who are OSM members volunteering to moderate any severe interpersonal conflict in the community during mapping.]"*, as **comment-rating may escalate conflicts** instead of managing them. Some participants commented on how this prompt would require an additional guideline to use
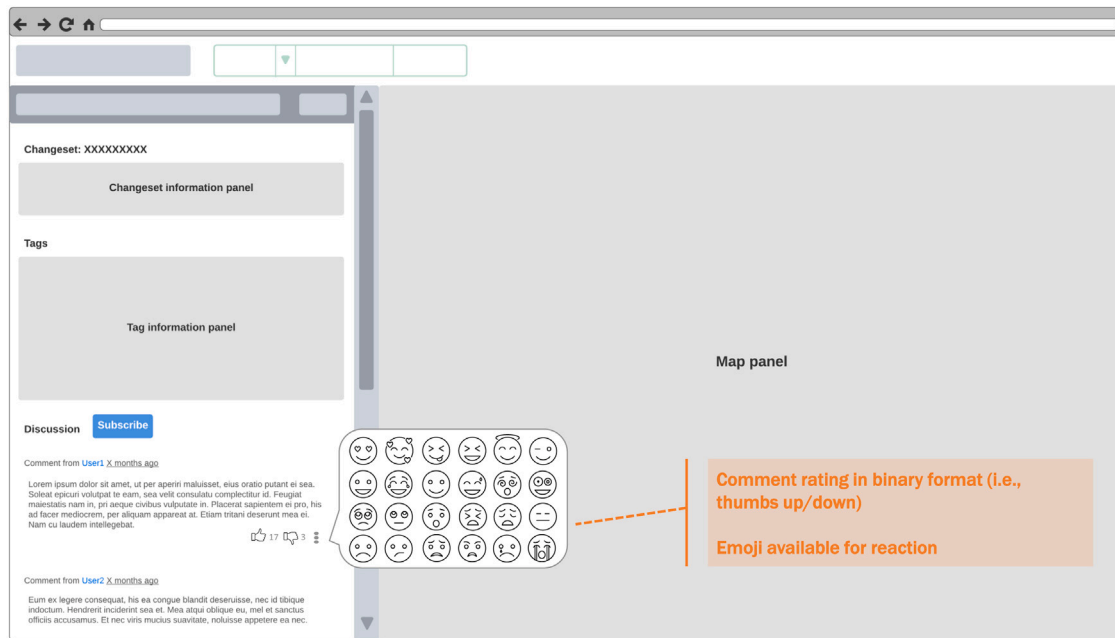
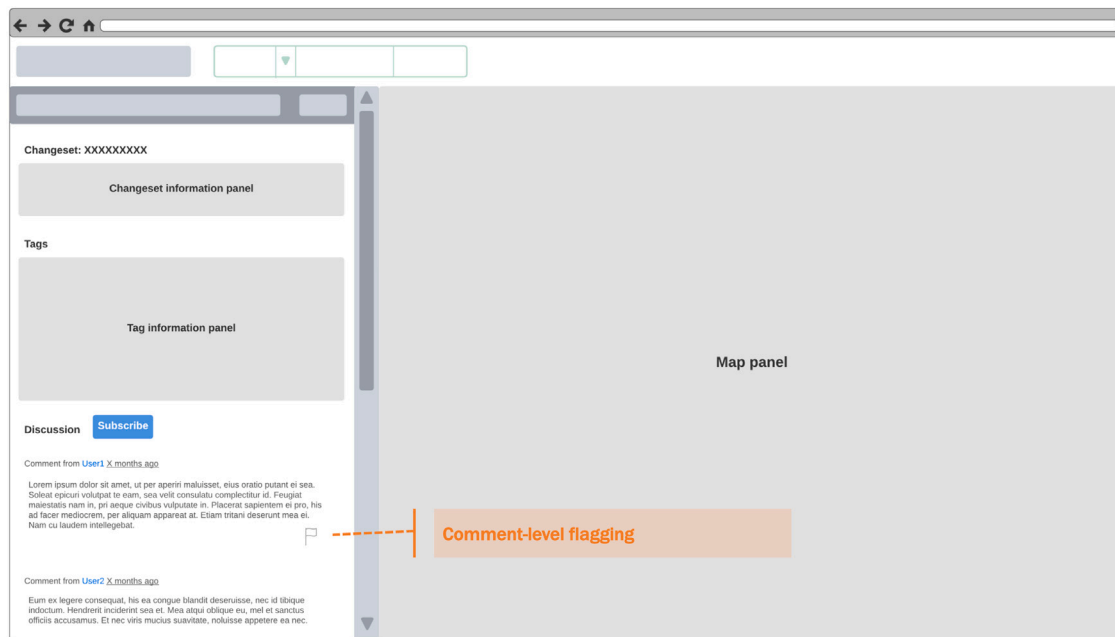**Fig. 15.** Suggestions to improve comment-rating prompt: emojis.

Fig. 16. Suggestions to improve comment-rating UI prompt: comment flagging.

the UI, and how even then some mappers may refuse to accept the guideline based on their previous experience of rating UI designs in other communities.

Improvements. Some participants suggested using emojis instead of rating comments as a more engaging design for expressing reactions to OSM Changeset comments (see Fig. 15). This could improve the UI usability and desirability. A concern was raised about emojis that may have different meanings in different cultures (e.g., okay sign, thumbs up). Other participants suggested flagging instead of rating comments (see Fig. 16), to notify moderators about comments perceived by mappers as problematic without needing to fill a form; *"It has a potential for abuse, but there is also a potential for minimizing the discussion going out of hand by reporting it".* (P8; P11; P12).

4.5. Visible user profile

Utility. Most participants either commented or agreed that a visible user profile was likely to have a positive utility in managing mapper conflict in OSM. In particular, they commented on the **likely change of behavior when mappers have information about mappers they engage with readily available** during the Changeset Discussion; *"Knowing whom I am interacting with will change my behavior"* (P1; P3). For example, participants who identified as long-term mappers mentioned that they will alter their behavior to be *"more welcoming and forgiving"* when interacting with a newcomer and to be *"less forgiving and probably more abrupt"* when interacting with a corporate editor (P1; P2; P3; P7; P10).

Participants suggested additional information that could be useful in conflict management, such as the number of edits and length of membership, which could provide a context of mappers (e.g., proxy indicator of their level of familiarity with the mapping activity, the level of expertise). However, some participants had **different opinions about what the number of edits and length of membership may represent** in the visible user profile and whether and how knowing this information would change their behaviors. Some participants mentioned that if the number of edits was visible next to a user ID, it will help members to *"understand why there might be an issue in what [the other mappers] have done [and will help mappers to be] more concise with their explanation"* (P1; P10), using several edits as a proxy for mappers' familiarity to OSM mapping activities. Other participants commented that the *"accuracy and completeness of the edit"* are more important indicators of mappers' expertise and reliability in OSM than the number of edits and length of community membership.

All the participants, however, were **concerned about which information to include in the visible user profile**. Revealing the geographic location of a mapper could be used to gain credibility or to *"question the user's local knowledge of the mapped area"* (P2). There was a concern about privacy and security; *"I don't feel comfortable by having so much information about me exposed"* (P12). Some participants who identified themselves as both volunteers and employees of OSM corporate partners commented how showing their professional affiliations in the OSM community would be *"unnecessary and redundant"* as it is already available in their user profiles in separate OSM web pages (P6; P7). Conversely, participants who identify themselves only as volunteers found the display of professional affiliation of OSM mappers as necessary; *"Corporate members are quite special because they are paid to [map on OSM] and [sometimes how they map] is not necessarily confirmed with what the local community has been doing"*. (P1; P2).

Some participants mentioned situations where the visible user profile may not be functional. For example, for mappers that already have conflicts, **exposing the user profile may not remedy the situation**. Other participants noted that **mappers may choose to discontinue their contributions if a visible user profile was made mandatory**. If opt-out was possible, they may choose not to share any information with other mappers at all, which will, in turn, make the visible user profile design meaningless. All participants either agreed or mentioned the **possible emergence of a division of mappers** stemming from the user information readily available on the profile; *"It also may potentially divide people into tribes [...]. I think I'm already seeing that just by reading a couple of discussions"*. (P11).

Usability. The majority of the participants agreed that the visible user profile could be **relatively easy to memorize and learn**. They also agreed that it **could improve the aesthetics** of the web interface, as long as it would not crowd the constrained space available to mapper comments in the Changeset Discussion; *"If it is well done, it could elevate the whole page in the aesthetic side of things and add a bit more life to OSM"*. (P2). Participants, however, shared concerns about how this design **may make some mappers feel unsafe and uncomfortable** revealing their user information, linking back to participants' comments on the design's utility.

Desirability. Three out of four groups commented how the visible user profile design is the **most engaging** among the four suggested design prompts. Two groups even used the term *humanizing* to describe how the visible user profile may help mappers to better engage with each other *"because people are showing their identity more"* (P2). The group that did not use the term *humanizing* noted that the design *"will be good in terms of understanding the context of the other users"* (P1; P2; P3; P4; P6). One group that did not think that the visible user profile may be engaging, emphasized examples of mappers not feeling safe to use the feature, making it less desirable for mappers than the other design prompts.

Adoptability. All participants mentioned the **difficulty of collecting relevant user information** for display and creating **redundancy**

Table 2
Summary of real-time polling results (%). Each participant had one vote per category.

Criteria	Current UI	Embedded text	Pop-up window	Comment rating	Visible user profile
Utility	0	**39.5**	12.5	18.8	29.3
Usability	0	**75**	0	12.5	12.5
Adoptability	0	**75**	0	12.5	12.5

by showing some user information that is already available on the OSM user page (a separate, distinct part of the OSM community toolset) such as the length of membership and the number of edits. They were also concerned about the backlash from both mappers who would, and those that would not accept this design. For the former, the challenge will be in reaching a consensus on what to include in the visible user profile. For the latter, their **preference for remaining anonymous** while online mapping is likely to be the key issue.

Improvements. Three groups made suggestions on making user information available as a text box that will appear when the mouse cursor hovers over the user IDs in the Changeset Discussion. They mentioned that this will *"less crowd the small space [available in the current UI]"* (P13) and help mappers feel *"somewhat safer"* (P12) in revealing their user information, together with the opt-out option. Two groups, including a group that suggested a 'mouse-hover' improvement suggested transforming the visible user profile into a badge system (see Fig. 17), with a possibility of implementing the same system across other OSM public online communication channels. Participants of this group commented that the design could attract mappers to contribute and engage with each other in 'civilized' behaviors, followed by their concerns on how such a system could make other mappers feel uncomfortable, even *"drifting into some kind of gamification, trying to impress others [...]. I think it would be splitting up the community into different classes"*. (P11).

One group suggested adding a photo of the mappers instead of a badge system (see Fig. 18). Instead of a user ID, the user photo would provide access to a summary of user information appearing upon a mouse cursor hovered on. Participants of this group noted how such a design alteration would add a humanizing factor. This was also acceptable to participants who felt that the badge system was too obtrusive.

Regardless of the improvements in the design, participants commented how including certain mapper information will be helpful to the overall online collaboration beyond conflict management. For example, mappers' interest in mapping specific geographic features (e.g., roads, bridges, hospitals, bike tracks) could provide important information to understand the mapper's experience and context of their OSM edits.

4.6. Real-time polling

The real-time polling, which was done at the end of the second-round discussion for each group, showed the participants' clear preference towards which design prompt was better than the other ones for utility, usability, and adoptability.

The poll was anonymized and collected as the percentage of participants voting for each item. Desirability was not included in the real-time polling process, as this criterion was only distilled from the participants' comments based on the analysis of the co-design workshop transcripts, as explained in Section 3.4. Table 2 shows the average percentage of participants that voted for each criterion.

No participants voted for the current design as having the best utility, usability, or adoptability, reflecting their opinions about its negative impact on online interpersonal conflict management. The embedded text was the prompt that received the highest votes on all three criteria, followed by the visible user profile, comment rating, and pop-up window prompts. The embedded text prompt received higher
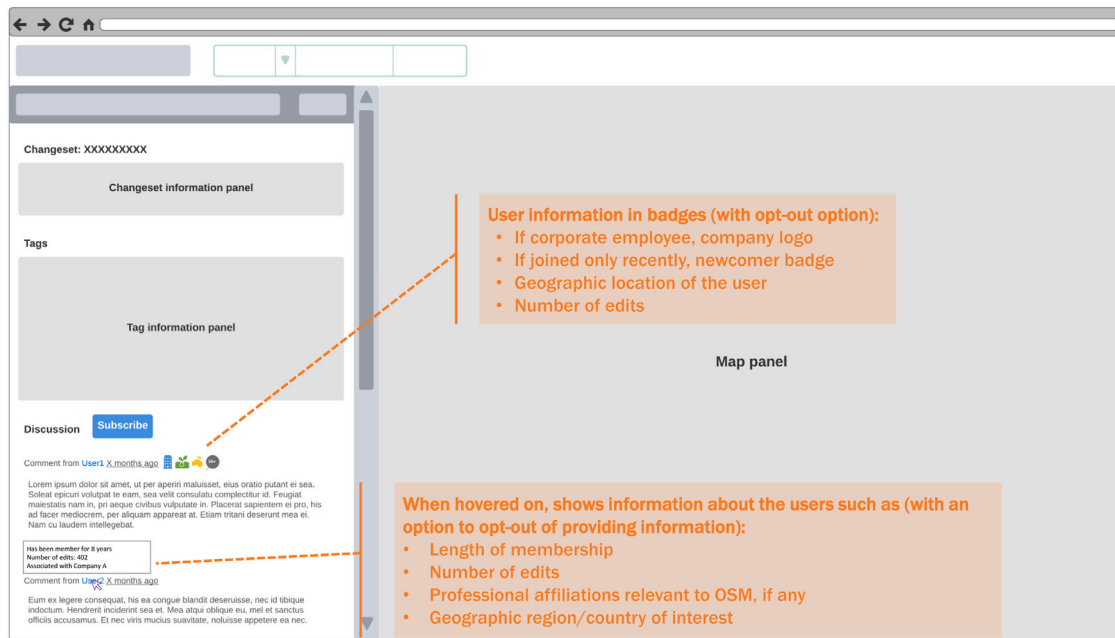
Fig. 17. Suggestions to improve the visible user profile prompt: badge system and user profile pop-up.
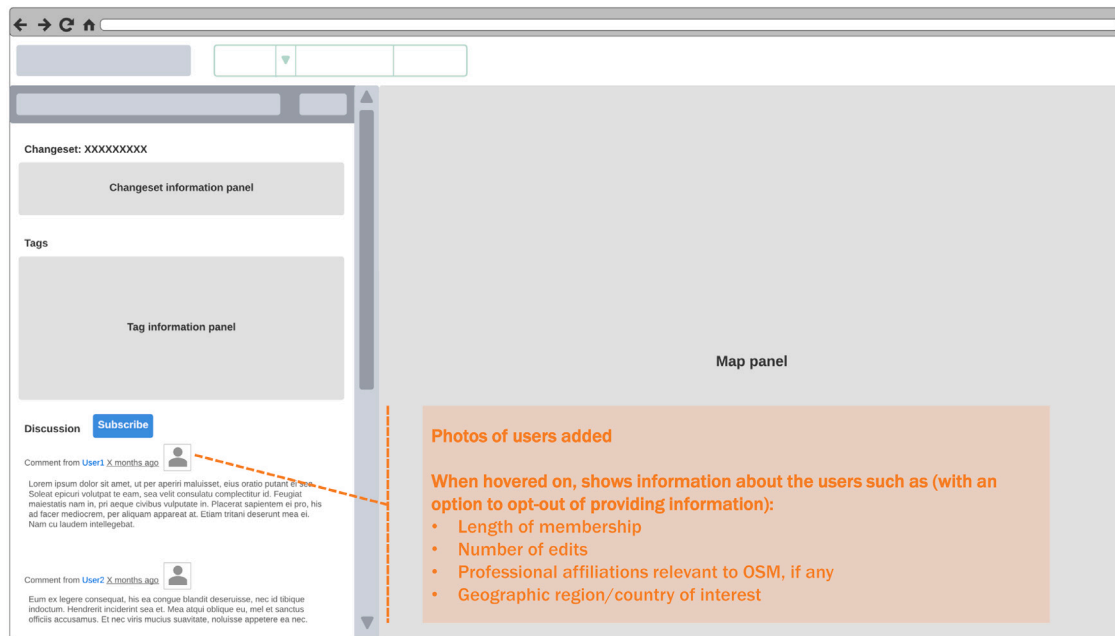

Fig. 18. Suggestions to improve visible user profile prompt: user photo.

votes on its usability and adoptability, compared to utility. This reflects the discussion where the embedded text was perceived as easy to use and simple, and therefore easily adopted by the community. However, its utility in conflict management remains somewhat questionable due to its simplicity. On the contrary, the visible user profile received higher votes on its utility, relative to its usability and adoptability. Again, this reflects the discussion results where participants agreed that this design will be useful in online conflict management by helping members adapt their behavior towards others. However, this design was perceived to be relatively less easy to use and had a higher possibility of backlash from mappers who do not wish to see any change in the current OSM Changeset Discussion UI.

5. Discussion

In this paper, we asked two questions of (1) *what are the mapper experiences with the current mapper conflict management UI of OSM Changeset Discussion* and (2) *How can this UI be improved?*. We conducted co-design workshops to assess the current UI and four possible design prompts. The overall experience of OSM mappers with the current design that we assessed from Section 4.1 is summarized as sub-optimal. Study participants agreed that the current UI design needs improvement in all four assessment criteria (i.e., utility, usability, adoptability, desirability). The four design prompts used in this study revealed certain user requirements across all four criteria (Sections 4.2 to 4.5). We extract two design guidelines from the focus group study results,

which may improve UI for online interpersonal conflict management in OPPCs.

5.1. Gentle and non-intrusive reminders customized based on OPPC producer profile

The first design guideline is to **include a gentle reminder that is visible, legible, and non-intrusive regarding expected online behaviors that could minimize the occurrence of interpersonal conflict.** This is to address significant commonalities in UI improvements that were found throughout Section 4, regardless of the participants' backgrounds and experiences. All participants commented or agreed on how they would prefer having a gentle reminder about how to interact with other members as in the embedded text design option from Section 4.2, or implicit and subtle design components. As such, a design component such as embedded text could be included in an improved UI of OSM Changeset Discussion to enhance both procedural clarity and desired online behavior. Similarly, they shared a dislike of any intrusive design component that would interrupt their main activity in OSM (i.e., mapping) such as a pop-up window design option in Section 4.3, or any component that was deemed to be visually too loud or *patronizing*.

Therefore, our study results add to the importance of using gentle and non-patronizing reminders to improve users' experience (Kray et al., 2004; Koebel et al., 2021) by showing that such a design could improve the user experience of interacting with other members as part of an online community through UIs. They noted a fine line between encouragement and manipulation/coercion of online collaboration behaviors in OPPCs via UI, particularly when it comes to conflict management. To address such concerns and to maintain the consistency of wordings that are used on the OSM website, such reminders should be aligned with the wordings from expected online behaviors listed on the Etiquette Guideline (i.e., document equivalent to other OPPCs code of conduct) (OpenStreetMap, 2021a), Organized Editing Guideline (OpenStreetMap, 2019), and/or any other relevant community guidelines (Osman, 2013; Li et al., 2021).

For an advanced design option, the chosen content of the reminders can be customized according to user profiles. Customized messages are proven to be effective in changing human behaviors to achieve a goal (Kreuter et al., 2013; Auer and Griffiths, 2020; Khan et al., 2021), in particular in peer-production environment, prompts could impact how peer-producers collaborate with each other (Heimbuch et al., 2018). For example, errors made by newcomers or hostile behaviors from long-term members could be potential factors leading to interpersonal conflict (Choe et al., 2023a). Reminders for newcomers can be customized to reduce and prevent error, whereas, for long-term members, reminders on showing empathy and welcome would be more effective in minimizing unnecessary interpersonal conflict.

One real-world example for this design guideline includes Stack Overflow's reminder in Fig. 19. A reminder on the top of the Figure appears for those members who are answering questions posted by newcomers. Text in a yellow box is a more generic reminder about expected and undesirable online collaborative behaviors that target all members who answer questions. These UI examples show how delivering a customized and gentle message could prevent error and lower occurrences of unnecessary online interpersonal conflict in OPPCs.

5.2. Customized user profile information displayed during online discussion

Improving online social presence through various UI components has been shown to lead to productive and trust-building user experience in online communities (Hassanein and Head, 2004; Hess et al., 2009; Venkatanathan et al., 2014; Wijenayake et al., 2020, 2022). Results from Section 4.5, show that the visible user profile UI option could improve social online presence and hence help OSM mappers to change their behavior to minimize online interpersonal conflict. Having certain

relevant information, as shown in Section 4.5, readily visible could support OSM members to choose the right conflict management strategy accordingly. Our results also show that providing an option to opt in or out of displaying certain user profile information would help OPPC members feel comfortable and safe using the UI. This could reduce any resistance to change. Based on these results, we suggest our second design guideline, that is, to **provide multiple options for members to choose regarding their user profile information displayed during online discussion.** If a designer decides to apply this design guideline, we propose to include some mandatory details such as the number of accurate/complete edits or preferred method of communication as suggested by the focus group participants in Sections 4.1 and 4.5.

For example, the number of accurate/complete edits was mentioned by the participants as a proxy indicator that divides the newcomer versus experienced mappers. Our results show that mappers would choose more welcoming and friendly tones on OSM Changeset Discussion if the other mappers are revealed to be newcomers. Having such information readily available as part of the user profile information could help OSM mappers to better understand the level of experiences that other mappers have, and hence choose different conflict management approaches accordingly, as shown in Section 4.5.

Another example is enabling members to display one or more of their preferred communication methods for discussing any potential errors on Changesets. People's communication styles are deeply affected by where they are from (i.e., geographic location) and in which culture they live (i.e., cultural differences) (Smith, 2004; Wang et al., 2009; Zakaria, 2017). Our findings in Section 4.1 indicate that such different communication styles could also affect the preferred type of communication methods. To support such existing behavior, a UI can allow them to display their preferred communication methods. When a member chooses their preferred communication methods, it will appear next to their user ID on a Changeset Discussion comment in relevant icons (e.g., comment icon, email icon, message icon); or can be shown in a text box when a mouse hovers on a user ID on a Changeset Discussion comment.

Members could also opt in (or opt out) to display different information in their user profiles, depending on their preferences. For example, members can opt-in to display their photo to add a humanizing factor during an online discussion on Changeset Discussion. Users can opt-out from displaying other details such as gender, geographic location, or length of membership which may not be the most relevant information to gauge their credibility. This will provide members with a sense of control and autonomy as we found throughout Section 4.

A real-world example of the visible user profile is found in OPPCs such as Github. As shown in Fig. 20, the user being a newcomer is readily displayed as part of the user's profile, which brings the context of each user as a fellow collaborator.

The two design guidelines that are derived from our results can be implemented in OPPCs to shape a platform that supports *peer-production* rather than encourage making a point, or winning an argument. The origin of peer-production started from a premise that a community of users with diverse background can co-create a valuable product through decentralized and informal structure (Benkler, 2017). As OPPCs get bigger in their number of users and the quantity of products, OPPCs can no longer rely on such premise to its purest form (Kreiss et al., 2011). Hence, they create conflict management strategies and tools as discussed in 2.2. The design guidelines that are identified from this study support such efforts in OPPCs to remind users of common goal of peer-producing a valuable product and of achieving such goal with minimized cost (i.e., not wasting their time making a point or winning an argument) (Asadi et al., 2013).

Our results also show the potential of a co-design workshop as a method that collects and analyzes user experiences that are common and different throughout multiple groups from an OPPC. While the design guidelines of our study are specific to OSM's context, the study design can be applied to other OPPCs to assess user experiences. Such
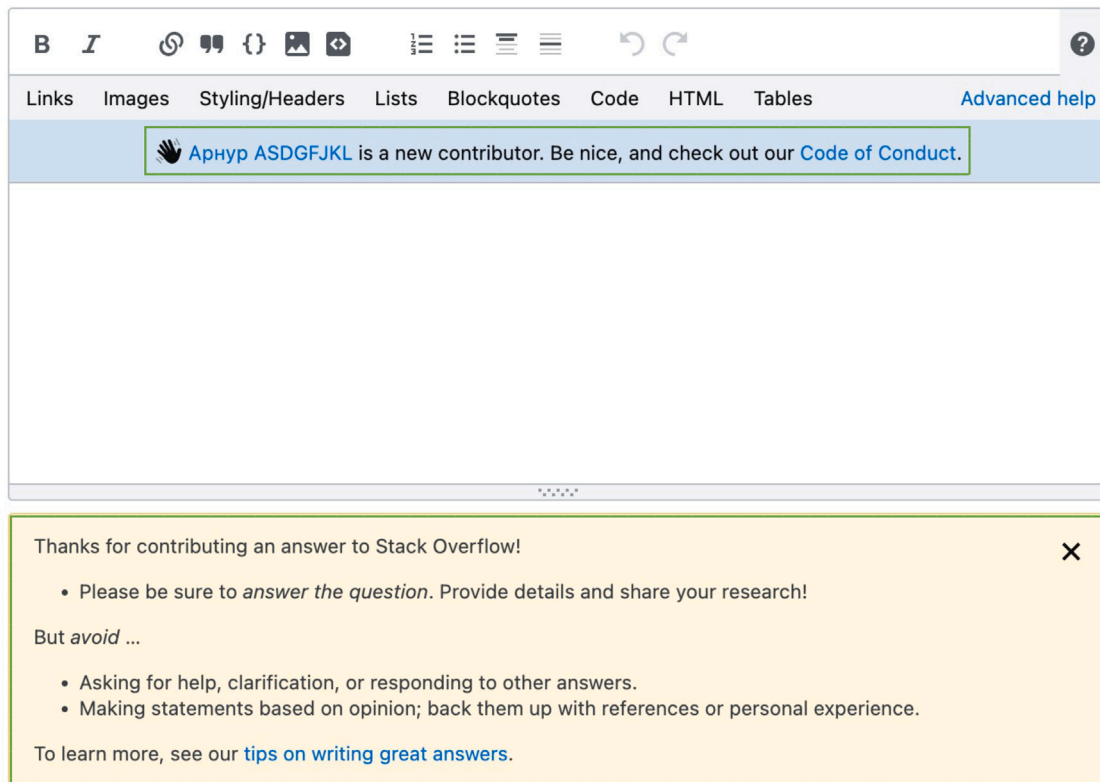
Fig. 19. Example of gentle, non-intrusive, and customized reminder from Stack Overflow in green-dotted boxes (https://www.stackoverflow.com/).

Fig. 20. Example of customized user profile information displayed from Github in green-dotted boxes (https://www.github.com/).

a user-participatory method allows a designer to collect common and different user experiences found in multiple user groups, identifying inclusive pain points for various user scenarios. In the next section, we discuss the potential challenges of applying our design guidelines in OPPCs.

5.3. Challenges in co-designing a user interface in open peer-production communities

One challenge that the participants mentioned throughout the co-design workshop process is difficulty of minimizing resistance from the OSM users regarding any change that is made in the community. OSM members are active in local, country-level, or broader regional communities with different mapping practices and preferred communication channels. Individual members have preferences concerning mapping particular types of geospatial objects, tagging styles, mapping methods, and communication styles. Such differences and diversities in background and individual preferences impact how people engage themselves to shape the communities and platforms based on their value system and agenda (Howard and Irani, 2019). Participants were concerned about the ability to reach a consensus about the re-design among the diverse, global member base of OPPCs:

"There will be some people who will find [the simple change on the UI] ridiculous, saying 'is this necessary?' [...] I don't think they would like any changes". (P11)

"There is still a lot of resistance (in the community) to the Etiquette Guidelines [...] Up until now, we did our best to factor in [the community's opinion], with a community-centered approach–We did community discussions, OSM wiki, mailing lists. And we still receive questions on [the Etiquette Guideline] from users. One of the root problems is that there is no consensus yet and there is still resistance [after all this time]". (P13)

"It is a small number of people that would decide to accept or reject [any changes on the UI]. I mean, there is a large community that would influence those people, but they are a small number of decision-makers". (P7)

Our results show that making incremental, continuous changes based on user feedback would be crucial to minimize any user resistance. The user-participatory process used in this paper encouraged participants to assess these trade-offs across the design prompts, emphasizing distinct aspects of the user experience. For example, participants discussed whether the simplicity of the design (e.g., embedded text) is more important than the rich functionality of the design (e.g., the visible user profile). Those who supported the importance of simplicity were concerned about usability and ease of use. They emphasized that a simple, minimal design alteration will also support adoptability, making both the technical implementation easy and leading to user acceptance without substantial backlash, even if it meant that the utility concerning member conflict management would not be optimal. Those who emphasized the importance of functionality were concerned about maximizing the effect of conflict management, that is, focusing primarily on the qualities of the UI that would enable minimizing unnecessary member conflict and support the development of a mutually agreeable solution, even if this meant a greater compromise on the UI design usability, desirability, and adoptability. As these design prompts are not mutually exclusive, future work could design multiple UIs based on the design prompts. Further investigation could be done to assess the effectiveness of each UI's conflict management through user-participatory methods, potentially answering the following questions: What will be the test method? Which members will be targeted for the experiment? Who will decide which UI design option to test?

Another challenge is the heterogeneity of any co-design study results that involve OPPCs. While OPPCs may share similarities in terms of their user diversity, openness, and online environment, their user behaviors may be different in different OPPCs. This means that the design guidelines suggested in this study may or may not work in another OPPC. We based our design prompts based on the examples of other OPPCs as shown in Section 2, under the assumption of OPPC members will behave similarly regardless of which communities they contribute. However, our findings show that the designs that work on other OPPCs may not work for OSM. Thus, it would be important for designers to be conscious of differences in user behaviors in different OPPCs, when co-designing a user interface with the communities.

6. Limitations and future work

This study has collected and analyzed OPPC producers' opinions on online UI design options. Due to the nature of our study targeting a global online community, the focus group study was organized via an online teleconference system. It efficiently accommodated the varying time zones and geographic locations of the participants. Yet, this also put limitations on the extent to which participants were able to build rapport and have as free and organic a discussion as they could have in an in-person setting. A future study could be designed to collect OPPC members' opinions at a face-to-face venue, such as the OSM State of the Map conference.

Our analysis results are limited by our analysis method, which is to categorize the contents into four design assessment criteria of utility, usability, adoptability, and desirability. A future study could

benefit from proxy indicators that could quantitatively capture these design criteria. The analysis results are to an extent also limited by the participant's selection bias, due to the limitations of an online participant recruitment process (see Section 3.3). While we distributed our advertisements (in English) broadly through a variety of communication channels, the diversity of OPPC communities and channels they use means that there are likely communities (incl. those that do not speak English) that have not been reached. Hence, a range of opinions may have been missed. A follow-up study could attempt to recruit participants with more diverse backgrounds to fully capture the user experience of conflict management in OPPCs. Such a study could be complemented by methods such as heuristic evaluation with utility and/or usability experts on the design prompts to validate the results.

The aim of this study was to investigate mapper experience with the current mapper conflict management UI and how it could be improved, in the hopes of supporting better data quality and mapper experience of co-producing data within the community. Based on our definition of *interpersonal conflict* in OSM, we view cartographic vandalism (Neis and Zipf, 2012; Ballatore, 2014; Truong et al., 2018; Juhász et al., 2020) as an example of extreme example of conflict in OSM, but not exclusively focused on addressing such vandalism in the community. Insights gained from this study could be further applied in designing the UIs in OSM to minimize cartographic vandalism. We believe that the recommendations discussed in Section 5 can be applied to other OPPCs due to their inherent peer-production similarities and online tooling. This should be, however, further investigated via comparative studies.

7. Conclusions

In this paper, we conducted a co-design workshop to identify improvements to the current interpersonal conflict management tool during the data co-production process in OSM called Changeset Discussion. Results of the study show that design prompts with minimal intrusion may have high usability and adoptability both by the OPPC platform and members, yet at the cost of utility. The design prompts with more complicated and more intrusion may have high utility but at the cost of sub-optimal usability and adoptability. Based on such results, we suggested two design guidelines (1) including gentle and non-intrusive reminders that are customized based on OPPC member profile and (2) providing OPPC members with multiple options to choose from regarding their profile information to be displayed online discussion. Our future work will focus on designing an A/B study to evaluate these features and their contribution, quantitatively.

CRediT authorship contribution statement

Youjin Choe: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Senuri Wijenayake:** Writing – review & editing, Methodology, Conceptualization. **Martin Tomko:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Mohsen Kalantari:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

References

Ali, A.L., Schmid, F., Al-Salman, R., Kauppinen, T., 2014. Ambiguity and plausibility. In: Proceedings of the 22nd ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems - SIGSPATIAL '14. pp. 143–152. http://dx.doi.org/10.1145/2666310.2666392.

Anderson, J., Sarkar, D., Palen, L., 2019. Corporate editors in the evolving landscape of OpenStreetMap. ISPRS Int. J. Geo-Inf. 8 (5), 232–249. http://dx.doi.org/10.3390/ijgi8050232.

Arazy, O., Nov, O., Patterson, R., Yeo, L., 2011. Information quality in wikipedia: The effects of group composition and task conflict. J. Manage. Inf. Syst. 27 (4), 71–98. http://dx.doi.org/10.2753/mis0742-1222270403.

Arazy, O., Yeo, L., Nov, O., 2013. Stay on the Wikipedia task: When task-related disagreements slip into personal and procedural conflicts. J. Am. Soc. Inf. Sci. Technol. 64 (8), 1634–1648. http://dx.doi.org/10.1002/asi.22869.

Asadi, S., Ghafghazi, S., Jamali, H.R., 2013. Motivating and discouraging factors for Wikipedians: the case study of Persian Wikipedia. Libr. Rev. 62 (4/5), 237–252.

Auer, M., Griffiths, M.D., 2020. The use of personalized messages on wagering behavior of Swedish online gamblers: An empirical study. Comput. Hum. Behav. 110, 106402.

Ballatore, A., 2014. Defacing the map: Cartographic vandalism in the digital commons. Cartogr. J. 51 (3), 214–224. http://dx.doi.org/10.1179/1743277414Y.0000000085.

Ballatore, A., Mooney, P., 2015. Conceptualising the geographic world: the dimensions of negotiation in crowdsourced cartography. Int. J. Geogr. Inf. Sci. 29 (12), 2310–2327. http://dx.doi.org/10.1080/13658816.2015.1076825.

BBC.com, 2019. Facebook uses AI to map Thailand's roads. URL: https://www.bbc.com/news/technology-49091093.

Benkler, Y., 2017. Peer production, the commons, and the future of the firm. Strateg. Organ. 15 (2), 264–274.

Bevan, N., 2009. What is the difference between the purpose of usability and user experience evaluation methods. In: Proceedings of the Workshop UXEM. Vol. 9, Citeseer, pp. 1–4.

Bista, S.K., Nepal, S., Colineau, N., Paris, C., 2012. Using gamification in an online community. In: 8th International Conference on Collaborative Computing: Networking, Applications and Worksharing. CollaborateCom, IEEE, New Jersey, USA, pp. 611–618.

Chhabra, A., Kaur, R., Iyengar, S., 2020. Dynamics of edit war sequences in Wikipedia. In: Proceedings of the 16th International Symposium on Open Collaboration. pp. 1–10.

Chittor, R., Naghizade, E., Borovica-Gajic, R., Tomko, M., 2022. Can you Fixme? An intrinsic classification of contributor-identified spatial data issues using topic models. Int. J. Geogr. Inf. Sci. 36 (1), 1–30. http://dx.doi.org/10.1080/13658816.2021.1893323.

Choe, Y., Tomko, M., Kalantari, M., 2023a. Assessing mapper conflict in OpenStreetMap using the delphi survey method. In: Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems. In: CHI '23, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450394215, p. 17. http://dx.doi.org/10.1145/3544548.3580792.

Choe, Y., Tomko, M., Kalantari, M., 2023b. Producer conflict management approaches in online peer production communities – case study of OpenStreetMap. In: Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems. In: CHI '23, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450394215, p. 12. http://dx.doi.org/10.1145/3544548.3581036.

da Silva Melo, Á.H., Oran, A.C., Silva dos Santos, J., Tamayo, S.C., Viana, D., Rivero, L., da Silva Barreto, R., 2022. From requirements to prototyping: Proposal and evaluation of an artifact to support interface design in the context of autism. In: International Conference on Human-Computer Interaction. Springer, pp. 307–321.

Danescu-Niculescu-Mizil, C., Kossinets, G., Kleinberg, J., Lee, L., 2009. How opinions are received by online communities: a case study on amazon. com helpfulness votes. In: Proceedings of the 18th International Conference on World Wide Web. Association for Computing Machinery, New York, USA, pp. 141–150.

David, S., Sabiescu, A.G., Cantoni, L., 2013. Co-design with communities. a reflection on the literature. In: Proceedings of the 7th International Development Informatics Association Conference. IDIA Pretoria, South Africa, pp. 152–166.

Dumais, S., Jeffries, R., Russell, D.M., Tang, D., Teevan, J., 2014. Understanding user behavior through log data and analysis. In: Ways of Knowing in HCI. Springer, Berlin, Germany, pp. 349–372.

Filippova, A., Cho, H., 2015. Mudslinging and manners: Unpacking conflict in free and open source software. In: Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work and Social Computing. Association for Computing Machinery, pp. 1393–1403. http://dx.doi.org/10.1145/2675133.2675254.

Girres, J.-F., Touya, G., 2010. Quality assessment of the French OpenStreetMap dataset. Trans. GIS 14 (4), 435–459. http://dx.doi.org/10.1111/j.1467-9671.2010.01203.x.

Glenski, M., Pennycuff, C., Weninger, T., 2017. Consumers and curators: Browsing and voting patterns on reddit. IEEE Trans. Comput. Soc. Syst. 4 (4), 196–206.

Grudin, J., 1992. Utility and usability: research issues and development contexts. Interact. Comput. 4 (2), 209–217.

Hassanein, K.S., Head, M., 2004. Building online trust through socially rich web interfaces. In: Proceedings of the 2nd Annual Conference on Privacy, Security and Trust, Fredericton, New Brunswick, Canada. pp. 15–22.

Heimbuch, S., Ollesch, L., Bodemer, D., 2018. Comparing effects of two collaboration scripts on learning activities for wiki-based environments. Int. J. Comput.-Supported Collab. Learn. 13, 331–357.

Hess, T.J., Fuller, M., Campbell, D.E., 2009. Designing interfaces with social presence: Using vividness and extraversion to create social recommendation agents. J. Assoc. Inf. Syst. 10 (12), 1.

Hornbæk, K., 2006. Current practice in measuring usability: Challenges to usability studies and research. Int. J. Hum.-Comput. Stud. 64 (2), 79–102.

Howard, D., Irani, L., 2019. Ways of knowing when research subjects care. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems. pp. 1–16.

Hudspith, S., 1997. Beyond utility: A framework for designing user experience. In: Proceedings of the Human Factors and Ergonomics Society Annual Meeting. SAGE Publications Sage CA: Los Angeles, CA, pp. 447–450.

Jaljolie, R., Dror, T., Siriba, D.N., Dalyot, S., 2023. Evaluating current ethical values of OpenStreetMap using value sensitive design. Geo-Spatial Inf. Sci. 26 (3), 362–378.

Juhász, L., Novack, T., Hochmair, H.H., Qiao, S., 2020. Cartographic vandalism in the era of location-based games—The case of OpenStreetMap and Pokémon GO. ISPRS Int. J. Geo-Inf. 9 (4), 197.

Keen, P.G., 1981. Information systems and organizational change. Commun. ACM 24 (1), 24–33.

Kennedy, A., Cosgrave, C., Macdonald, J., Gunn, K., Dietrich, T., Brumby, S., 2021. Translating co-design from face-to-face to online: an Australian primary producer project conducted during COVID-19. Int. J. Environ. Res. Public Health 18 (8), 4147.

Khan, M., Fernandes, G., Maes, P., 2021. Users want diverse, multiple, and personalized behavior change support: Need-finding survey. In: International Conference on Persuasive Technology. Springer, pp. 245–255.

Koebel, K., Lacayo, M., Murali, M., Tarnanas, I., Çöltekin, A., 2021. Expert insights for designing conversational user interfaces as virtual assistants and companions for older adults with cognitive impairments. In: International Workshop on Chatbot Research and Design. Springer, pp. 23–38.

Kray, C., Kortuem, G., Wasinger, R., 2004. Concepts and issues in interfaces for multiple users and multiple devices. In: Workshop on Multi-User and Ubiquitous User Interfaces (MU3I) At IUI 2004.

Kreiss, D., Finn, M., Turner, F., 2011. The limits of peer production: Some reminders from Max Weber for the network society. New Media Soc. 13 (2), 243–259.

Kreuter, M.W., Farrell, D.W., Olevitch, L.R., Brennan, L.K., 2013. Tailoring Health Messages: Customizing Communication with Computer Technology. Routledge.

Kujala, S., Roto, V., Väänänen-Vainio-Mattila, K., Karapanos, E., Sinnelä, A., 2011. UX Curve: A method for evaluating long-term user experience. Interact. Comput. 23 (5), 473–483.

Lazar, J., Feng, J.H., Hochheiser, H., 2017. Research Methods in Human-Computer Interaction. Morgan Kaufmann, Burlington, USA.

Li, R., Pandurangan, P., Frluckaj, H., Dabbish, L., 2021. Code of conduct conversations in open source software projects on Github. Proc. ACM Hum.-Comput. Interact. 5 (CSCW1), 1–31.

Lin, Y.W., 2011. A qualitative enquiry into OpenStreetMap making. New Rev. Hypermedia Multimedia 17 (1), 53–71. http://dx.doi.org/10.1080/13614568.2011.552647.

Mahlke, S., Thüring, M., 2007. Studying antecedents of emotional experiences in interactive contexts. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 915–918.

McGrath, O.G., 2005. Gauging adoptability: a case study of e-portfolio template development. In: Proceedings of the 33rd Annual ACM SIGUCCS Conference on User Services. pp. 214–217.

Menking, A., Erickson, I., 2015. The heart work of Wikipedia: Gendered, emotional labor in the world's largest online encyclopedia. In: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems. pp. 207–210.

Mooney, P., Corcoran, P., Winstanley, A.C., 2010. Towards quality metrics for OpenStreetMap. In: Proceedings of the 18th SIGSPATIAL International Conference on Advances in Geographic Information Systems. GIS '10, Association for Computing Machinery, New York, NY, USA, pp. 514–517. http://dx.doi.org/10.1145/1869790.1869875.

Mourouzis, A., Antona, M., Boutsakis, E., Stephanidis, C., 2005. An evaluation framework incorporating user interface accessibility. In: Universal Access in HCI: Exploring New Dimensions of Diversity. Vol. 8.

Naqshbandi, K., 2023. Facilitating Prosociality Through Technology: Design to Promote Digital Volunteerism (Ph.D. thesis).

Neis, P., Zipf, A., 2012. Analyzing the contributor activity of a volunteered geographic information project – the case of OpenStreetMap. ISPRS Int. J. Geo-Inf. 1 (2), 146–165. http://dx.doi.org/10.3390/ijgi1020146, URL: https://search.ebscohost.com/login.aspx?direct=true&AuthType=sso&db=a9h&AN=84498050&site=ehost-live&custid=s2775460.

Onwuegbuzie, A.J., Dickinson, W.B., Leech, N.L., Zoran, A.G., 2009. A qualitative framework for collecting and analyzing data in focus group research. Int. J. Qual. Methods 8 (3), 1–21.

OpenStreetMap, 2019. Organised editing guidelines. URL: https://wiki.openstreetmap.org/wiki/Etiquette/Etiquette_Guidelines.

OpenStreetMap, 2021a. Etiquette/etiquette guidelines. URL: https://wiki.openstreetmap.org/wiki/Etiquette/Etiquette_Guidelines.

OpenStreetMap, 2021b. Good changeset comments. URL: https://wiki.openstreetmap.org/wiki/Good_changeset_comments.

OpenStreetMap, 2022. Stats. URL: https://wiki.openstreetmap.org/wiki/Stats.

Osman, K., 2013. The role of conflict in determining consensus on quality in wikipedia articles. In: Proceedings of the 9th International Symposium on Open Collaboration. WikiSym '13, Association for Computing Machinery, New York, NY, USA, pp. 1–6. http://dx.doi.org/10.1145/2491055.2491067.

Porcaro, L., Gómez, E., Castillo, C., 2022. Diversity in the music listening experience: Insights from focus group interviews. In: ACM SIGIR Conference on Human Information Interaction and Retrieval. pp. 272–276.

Quattrone, G., Mashhadi, A., Capra, L., 2014. Mind the map: the impact of culture and economic affluence on crowd-mapping behaviours. In: Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work and Social Computing. Association for Computing Machinery, pp. 934–944. http://dx.doi.org/10.1145/2531602.2531713.

Ren, R., Yan, B., 2017. Crowd diversity and performance in wikipedia: The mediating effects of task conflict and communication. In: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. CHI '17, Association for Computing Machinery, New York, NY, USA, pp. 6342–6351. http://dx.doi.org/10.1145/3025453.3025992.

Russell, J., 2018. Grab is messing up the world's largest mapping community's data in Southeast Asia. URL: https://techcrunch.com/2018/12/19/grab-maps-osm-thailand-southeast-asia/.

Schröder-Bergen, S., Glasze, G., Michel, B., Dammann, F., 2022. De/colonizing OpenStreetMap? Local mappers, humanitarian and commercial actors and the changing modes of collaborative mapping. GeoJournal 87 (6), 5051–5066.

Singh, V., 2019. Women participation in open source software communities. In: Proceedings of the 13th European Conference on Software Architecture-Volume 2. pp. 94–99.

Smith, P.B., 2004. Acquiescent response bias as an aspect of cultural communication style. J. Cross-Cult. Psychol. 35 (1), 50–61.

Touya, G., Antoniou, V., Olteanu-Raimond, A.-M., Damme, M.-D.V., 2017. Assessing crowdsourced POI quality: Combining methods based on reference data, history, and spatial relations. ISPRS Int. J. Geo-Inf. 6 (3), http://dx.doi.org/10.3390/ijgi6030080, URL: https://www.mdpi.com/2220-9964/6/3/80.

Truong, Q.T., Touya, G., de Runz, C., 2018. Towards vandalism detection in OpenStreetMap through a data driven approach. In: GIScience 2018. Schloss Dagstuhl–Leibniz-Zentrum fuer Informatik, pp. 61:1–61:7.

Truong, Q.T., Touya, G., Runz, C.d., 2020. OSMWatchman: Learning how to detect vandalized contributions in OSM using a random forest classifier. ISPRS Int. J. Geo-Inf. 9 (9), 504.

Venkatanathan, J., Kostakos, V., Karapanos, E., Gonçalves, J., 2014. Online disclosure of personally identifiable information with strangers: Effects of public and private sharing. Interact. Comput. 26 (6), 614–626.

Villalobos, C., Morel, M.J., Treviño, E., 2021. What is a "good citizen"? a systematic literature review. In: Good Citizenship for the Next Generation. Vol. 12, Springer, Cham, Germany, pp. 13–32.

Wang, H.-C., Fussell, S.F., Setlock, L.D., 2009. Cultural difference and adaptation of communication styles in computer-mediated group brainstorming. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 669–678.

Wijenayake, S., van Berkel, N., Kostakos, V., Goncalves, J., 2022. Quantifying determinants of social conformity in an online debating website. Int. J. Hum.-Comput. Stud. 158, 102743. http://dx.doi.org/10.1016/j.ijhcs.2021.102743, URL: https://www.sciencedirect.com/science/article/pii/S1071581921001610.

Wijenayake, S., Van Berkel, N., Kostakos, V., Goncalves, J., 2020. Quantifying the effect of social presence on online social conformity. Proc. ACM Hum.-Comput. Interact. 4 (CSCW1), 1–22.

Wilson, C., 2013. Interview Techniques for UX Practitioners: A User-Centered Design Method. Newnes, London, UK.

Wu, K.W., Vassileva, J., Zhu, Q.H., Fang, H., Tan, X.J., 2013. Supporting group collaboration in Wiki by increasing the awareness of task conflict. Aslib Proc. 65 (6), 581–604. http://dx.doi.org/10.1108/ap-05-2013-0046.

Wu, K., Zhao, Y., Vassileva, J., Sun, X., Fan, Z., 2014. How does awareness of task conflict motivate wiki-based collaborative learning? A design science approach. In: PACIS. p. 261.

Yasseri, T., Sumi, R., Rung, A., Kornai, A., Kertész, J., 2012. Dynamics of conflicts in wikipedia. PLoS One 7, e38869. http://dx.doi.org/10.1371/journal.pone.0038869.

Zakaria, N., 2017. Emergent patterns of switching behaviors and intercultural communication styles of global virtual teams during distributed decision making. J. Int. Manag. 23 (4), 350–366.

Zhu, D., Li, A., Wang, N., Wu, J., Liu, W., 2021. Designed for designer: an online co-design workshop. In: Intelligent Human Systems Integration 2021: Proceedings of the 4th International Conference on Intelligent Human Systems Integration (IHSI 2021): Integrating People and Intelligent Systems, February 22-24, 2021, Palermo, Italy. Springer, pp. 856–861.