

---

# Who Uses Bots? A Statistical Analysis of Bot Usage in Moderation Teams

**Charles Kiene**  
University of Washington  
Seattle, WA, USA  
ckiene@uw.edu

**Benjamin Mako Hill**  
University of Washington  
Seattle, WA, USA  
makohill@uw.edu

## Abstract

Adopting new technology is challenging for volunteer moderation teams of online communities. Challenges are aggravated when communities increase in size. In a prior qualitative study, Kiene et al. found evidence that moderator teams adapted to challenges by relying on their experience in other technological platforms to guide the creation and adoption of innovative custom moderation “bots.” In this study, we test three hypotheses on the social correlates of user innovated bot usage drawn from a previous qualitative study. We find strong evidence of the proposed relationship between community size and the use of user innovated bots. Although previous work suggests that smaller teams of moderators will be more likely to use these bots and that users with experience moderating in the previous platform will be more likely to do so, we find little evidence in support of either proposition.

## Author Keywords

moderation; bots; online communities; population size; social computing; chat; computer-mediated communication; Reddit; Discord.

## CCS Concepts

•Human-centered computing → Empirical studies in collaborative and social computing; •Information systems → Chat; Web interfaces;

---

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

*CHI '20 Extended Abstracts, April 25–30, 2020, Honolulu, HI, USA.*

© 2020 Copyright is held by the author/owner(s).

ACM ISBN 978-1-4503-6819-3/20/04.

DOI: <https://doi.org/10.1145/3334480.3382960>

## Introduction

Groups that adopt new organizational technology face unanticipated problems resulting from a disconnect between technology designers' intentions and the group's technological frames [9, 10]. Other work has found that end user programming toolkits not only allow groups to develop innovative custom solutions to problems [14, 15], but that these solutions are often modeled after tools that groups used in prior settings. A 2019 study by Kiene et al. found that moderation teams for online communities that had adopted a new technological platform felt challenged as a result of the new platform's different affordances, limited built-in moderation tools, and problems from increasing community size [7]. These moderation teams adapted to technological change and problems caused by increasing community size by utilizing the new platform's public application programming interface (API) to develop, use, and share custom moderation "bots" that resembled moderation tools they used on the previous platform.

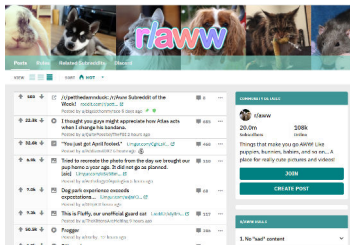
In this paper, we provide a quantitative test of three hypotheses drawn from Kiene et al. [7]. First, we test the proposition that membership size is positively associated with the deployment of user created moderation tools. Second, we test the proposition that smaller teams with fewer resources to devote to moderation will be more likely to adopt user innovated moderation bots. Finally, we examine whether teams with experience moderating in Reddit will be more likely to adopt user innovated moderation bots. To test these theories, we randomly sample 300 online communities on the chat platform Discord associated with communities on the social media platform Reddit. We found support for Kiene et al.'s claim that larger Discord communities will be more likely to adopt user created moderation tools and no evidence in support of the other propositions.

## Background

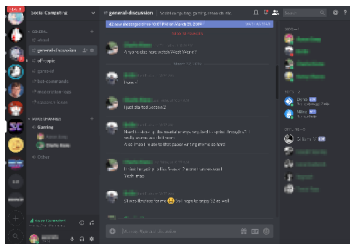
Increasing population size presents unique challenges for governing online communities [1, 8, 13]. For online communities managed by volunteer moderators, this challenge becomes even more problematic as volunteers often lack the resources to scale their work in response to increasing membership and activity [5, 7]. Volunteer moderators are tasked with shaping and maintaining norms in their communities [3, 12]. In many cases, moderation teams adopt user innovated tools in the form of "bots" to better scale their work in response to community growth [2, 4, 6, 7, 11].

In Kiene et al.'s 2019 study, the authors interviewed members of volunteer moderation teams from the social media platform Reddit, a social platform that hosts millions of online communities called "subreddits" (Figure 1)[7]. Each team had expanded into Discord, a synchronous chat application that also hosts millions of online communities called "servers" (Figure 2) as a second site for community interaction. Moderators expressed difficulties in managing their communities as a result of inadequate moderation tools on Discord as well as difficulties in scaling their work in response to increasing community growth. Moderation teams adapted to these challenges through end user programming innovations in the form of bots that facilitated moderation work. They also found that the features of the bots most frequently mentioned in interviews resembled features of moderation tools built into Reddit: AutoModerator, Mod Logs, and Mod Mail [7].

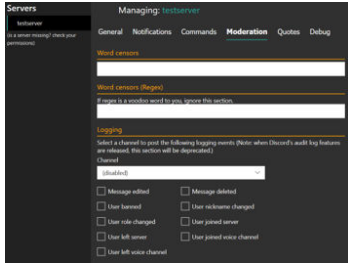
A bot with an "AutoModerator" (or "automod") like feature is depicted in Figure 3. This tool allows teams to scale content moderation by automation. Moderators use the tool to select which words, phrases, or even URLs should be filtered from their community; the bot will constantly scan the Discord community's chat channels and automatically delete messages according to parameters set by the moderation



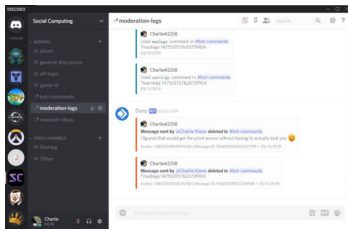
**Figure 1:** A screenshot of the user interface for a subreddit community.



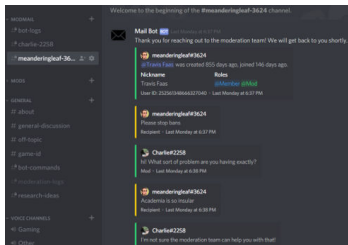
**Figure 2:** A screenshot of the user interface for the Discord application and a Discord community.



**Figure 3:** A screenshot of a Discord bot's automod tools.



**Figure 4:** A screenshot of the Discord bot “Dyno” and its mod logs feature.



**Figure 5:** A screenshot of a Discord bot's mod mail utility.

team. Figure 4 depicts a user-created bot that performs a “Mod Logs” like function. The “mod logs” functionality automatically records and stores information about community members’ interactions with the moderation team, such as when they’re warned for breaking a rule. Finally, some bots have a “Mod Mail” like feature, depicted in Figure 5, which aggregates messages from community members to the moderation team in a centralized location, usually a private chat channel that only the moderators can see. Kiene et al. found that all three of these tools were explicitly and closely modeled after Reddit’s moderation tools and all three use names that are similar to systems in Reddit.

Representatives of moderation teams from smaller Discord communities interviewed by Kiene et al. reported feeling less of a need to adopt user innovated tools to manage their communities[7]. Therefore, we expect that moderation teams of Discord-Reddit communities with more members will be more likely to adopt bots that facilitate automod, mod logs, and mod mail. This leads us to our first hypothesis: *(H1) Moderation teams of communities with larger memberships will be more likely to adopt bots with moderation features.*

Kiene et al. also found that moderation teams reported turning to bots in order to deal with the problem of limited volunteers[7]. In this sense, it stands to reason that larger teams will be less likely to adopt user innovated bots. This leads us to our second hypothesis: *(H2) Smaller moderation teams will be more likely to adopt bots with moderation features.*

Finally, Kiene et al. found that moderation teams relied heavily on their technological frames drawn from their experience in Reddit solving problems with Discord’s API[7]. This supports our final hypothesis: *(H3) Moderation teams with subreddit moderators will be more likely to adopt bots with moderation features.*

## Methods

### Data

Data for this study were collected over a three stage process from October to December of 2019. Following Kiene et al. we were interested in communities on Discord that were connected to communities on Reddit. To build a sample of these communities, we began with a complete list of 1,082,444 subreddit communities on Reddit published in April 20, 2018.<sup>1</sup> Next, we gathered data from each of these subreddits using the Reddit API. This data included each subreddit community’s total subscriber count and text in the “side bar”—a column of text on each subreddit’s page. These “side bars” often contain invite links to any Discord community associated with the subreddit. Discord communities can only be accessed through these invite links. Using regular expression searches as a method of capturing invite links to Discord servers, we filtered our initial data set for subreddit side bars that contained any URL containing `discord.gg/` or `discordapp.com/invite/`. This new data set contained 8,296 observations.

We observed that the distribution of total subscribers across subreddits in this data set was extremely right-skewed—i.e., there were many communities with very few subscribers. Because testing H1 requires variation in membership size, we stratified this data set into 10 bins based on the number of subscribers on an exponential scale. From each bin, we randomly sampled 30 subreddits with working Discord invite links. This resulted in a final data set of 300 Discord communities associated with communities on Reddit with a range of membership sizes. We followed invite links to visit each of these Discord servers and collected data on total community members, members online, number of moder-

<sup>1</sup>[https://www.reddit.com/r/ListOfSubreddits/comments/8drbn3/i\\_created\\_a\\_txt\\_list\\_of\\_all\\_subreddits\\_1082444\\_of/](https://www.reddit.com/r/ListOfSubreddits/comments/8drbn3/i_created_a_txt_list_of_all_subreddits_1082444_of/) (Archived at <https://perma.cc/FDN2-TDMT>)

| Var     | Min | Max     |
|---------|-----|---------|
| Members | 2   | 180,944 |
| Mods    | 0   | 20      |
| Bots    | 0   | 20      |

| Var     | $\mu_s$ | $\sigma_s$ |
|---------|---------|------------|
| Members | 6,731   | 20,194     |
| Mods    | 3.31    | 3.26       |
| Bots    | 3.50    | 3.52       |

| Var     | $\mu_w$ | $\sigma_w$ |
|---------|---------|------------|
| Members | 5,716   | 19,996     |
| Mods    | 2.75    | 2.97       |
| Bots    | 3.08    | 3.45       |

**Table 1:** Summary statistics for the Discord communities in our analysis. *s* subscripts indicate sample statistics and *w* subscripts indicate statistics re-weighted to compensate for over-sampling. ( $n = 300$ )

ators online, number of Reddit moderators, and the names and number of bots in each Discord community manually in a spreadsheet.

Kiene et al. 2019 found that many of the bots used by Discord moderators are published openly and reused across a range of communities[7]. After recording the names of each bot from each Discord server in our sample, we constructed a data set with details of each bot observed in our second data set by conducting Internet searches of the bot’s name for its documentation and recording whether the bot has any of the three moderation features referenced in the prior study: automod, mod logs, or mod mail. We then merged this bot-level data set with the community-level data set to identify which of the Discord communities had a bot that could perform automod, mod logs, or mod mail functions. Additionally, we manually checked each Discord’s community’s posted “rules” and information channels to determine if any bots we couldn’t find with Internet searchers were being explicitly referenced as moderation tools. In some cases, moderators would tell community members to message one of their bots to get in touch with the moderation team—information that reveal the presence of a mod mail bot. In total, we recorded 366 unique bot names, many of which were shared across multiple Discord communities. Of these, 32 bots have an automod feature, 45 bots have a mod logs feature, and 11 have a mod mail feature. Summary statistics for the final sample of projects used in our analysis can be found in Table 1.

#### Dependent variables

We constructed four dummy variables to capture variation in the presence or absence of user-innovated bots drawing on technological frames from Reddit. First, *automod* was marked as 1 for a community with any bot with an AutoModeration feature such as a customizable word or URL filter. *Mod logs* was recorded as 1 for any observation that had a

bot with mod logs feature. Finally, *mod mail* was recorded as 1 for communities with any bot with a mod mail feature or which was explicitly labeled with some variation of “mod mail bot.” We also constructed a dummy variable *Any* that was set to 1 if a community had any of the three bot variables.

#### Independent variables

To test *H1* about scale, our key question predictor is *members*, which we measure as each Discord community’s total members as published on the Discord server. We note that this captures the total offline and online community members. Although we also measured the number of people online, preliminary analyses revealed a strong, positive correlation between total community members and members online (Spearman’s  $\rho = 0.96$ ). To avoid colinearity in our models, we use only total community members because we believe it’s a more accurate measure of community size than the count of online members at the time of observation which could vary by time of day or day of the week.

Community members on Discord can be assigned custom “roles” that signify a members’ role in the community. In most cases, moderators are given some variation of a “Moderator” role by the community’s admins. To test *H2* about moderation team size, we construct a variable *mods* which we measure as the number of Discord members with any variation of a “moderator” or “admin” role.

In Kiene et al. 2019, the authors reported observing a number of Discord communities that had moderators who were explicitly given tags for the roles of “subreddit moderators.” To test *H3* about moderator experience in Reddit, we include the variable *redditmods* which we measure as a dummy variable set to 1 if a Discord community had moderators who were explicitly given the role “subreddit moderators” and 0 otherwise. In our data set, we observed a total

|                       | M1                 | M2                  |
|-----------------------|--------------------|---------------------|
| (Intercept)           | -1.80***<br>(0.35) | -3.09***<br>(0.57)  |
| $\ln(\text{members})$ | 0.20**<br>(0.06)   | -0.01<br>(0.10)     |
| $\ln(\text{mods})$    | 0.29<br>(0.22)     | 0.75*<br>(0.36)     |
| <i>redditmods</i>     | -0.22<br>(0.38)    | 0.30<br>(0.52)      |
| Deviance              | 384.79             | 190.53              |
|                       | M3                 | M4                  |
| (Intercept)           | -1.66***<br>(0.35) | -10.92***<br>(2.16) |
| $\ln(\text{members})$ | 0.18**<br>(0.06)   | 0.66**<br>(0.25)    |
| $\ln(\text{mods})$    | 0.23<br>(0.22)     | 1.33<br>(0.73)      |
| <i>redditmods</i>     | -0.35<br>(0.38)    | 0.61<br>(0.77)      |
| Deviance              | 388.66             | 58.50               |
| Num. obs.             | 300                | 300                 |

\*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$

**Table 2:** Statistical models and estimates for our four models. M1 is a logistic regression model of the probability that a Discord community will adopt *any* user innovated moderation bot. M2 - M4 are logistic regression models of the probability that a Discord community will adopt the three moderation tools: *automod* (M2), *mod logs* (M3), and *mod mail* (M4).

of 60 Discord communities that had at least one moderator with a “subreddit moderator” tag.

### Analytic strategy

Our analytic strategy employs a logistic regression on the probability that any of three moderation tools would appear on Discord communities in relation to community size (M1) or that each of the tools would appear individually (M2, M3, and M4). In preliminary explorations of our data, we noticed extreme right skew for the distributions of *members* and *mods*. As a result, we use the natural log of each covariate in our models. Finally, we apply weights in each of our analyses to compensate for the oversampling on large communities so that our results reflect the average effects among any Discord server in the population from which we sampled. Our first model (M1) estimates the probability that any of the three moderation tools are adopted through bots, and the other 3 models test the probability of encountering each moderation tool in turn. Each model took the same form with the response variable  $Y$  changing depending on which moderation tool we were testing for:

$$\text{logit}(Y) = \beta_0 + \beta_1 \log(\text{members}) + \beta_2 \log(\text{mods} + 1) + \beta_3 \text{redditmods}$$

## Results

Results of each statistical test of our models are illustrated in Table 2. Three of our four fitted models show support for H1. We found a statistically significant relationship between size and the adoption of any moderation bot (M1) as well as for a mod logs bot (M3) and a mod mail bot (M4). We did not find a statistically significant relationship between size and the likelihood of using a bot with the automod feature. Figure 6 depicts predicted values from all four models for prototypical Discord communities with varying community sizes holding the other variables at their sample median values. For example, We would expect a Discord community

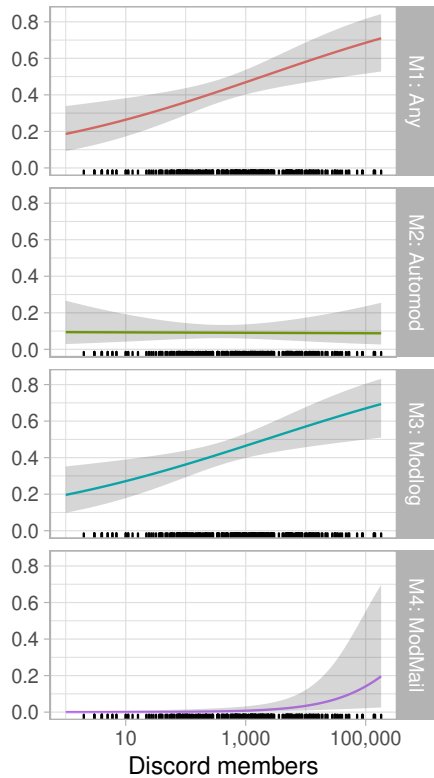
with 2 total members to have a 20% probability of having any user innovated moderation bot while a community with 939 members (the sample median) to have a 47% probability of having any user innovated moderation bot. A community with 13,568 members (90<sup>th</sup> percentile of our sample) would have a 60% probability of having any user innovated moderation bot.

In terms of H2, our models provided little in the way of compelling evidence in favor of the hypothesis. Although we consistently estimate a positive relationship between the number of moderators and the probability of adopting a user innovated moderation tool, we only estimate a statistically significant relationship between moderation team size and the probability of adopting an automod bot (M2). The relationship is opposite in sign to our prediction.

Our results for H3 are a consistent null finding. We found no statistically significant relationships between our measure of *redditmods* and the likelihood of adopting tools across any of our models.

## Discussion

Our statistical analyses reported in Table 2 and illustrated in Figure 6 provide evidence in support of H1. On average, moderation teams are more likely to adopt user innovated mod logs or mod mail tools in larger communities. Surprisingly, there was virtually no relationship between community size and the adoption of a user created automoderation tool. This finding was surprising in light of Seering et al.’s [11] finding where the authors found that larger Twitch streams resulted in more automated moderation activity from bots. This could be explained by the fact that while Twitch streams only allow one chat channel for community interactions, Discord affords the creation of up to 500 different chat channels in a single Discord community. Furthermore, these findings might be interpreted as suggesting



**Figure 6:** Predicted probabilities for each model based on a logged increase in community size. Tick marks on the x-axis indicate sample observations for community size. Shaded areas represent the 95% prediction interval.

that increasing community size leads to greater challenges related to logging member information and less problems for scaling content moderation.

Although the effect of community size on the probability of adopting a mod mail bot was small, this might be explained by the fact that most mod mail bots we observed in our sample were custom-built and self-hosted on private servers. On the other hand, almost all bots with mod log features in our sample were available as public services that did not require community moderators to self-host the bot on their own servers. This may explain the relatively widespread use of these bots in Discord communities in our sample. The positive association of the parameter estimates in M2 is opposite in sign for the effect we expected in H2. After controlling for the log-linear effect of community size, *larger* moderation teams are actually associated with a *higher* likelihood of adopting user innovated automod tools. In that  $\ln(\text{members})$  and  $\ln(\text{mods})$  are positively correlated (Pearson's  $\rho = 0.62$ ), we find that larger communities tend to have more mods. It is possible that our control for the log-linear effect of membership may be incomplete in ways that are reflected in our estimate of the marginal effect for  $\ln(\text{mods})$ . It is also possible that larger teams have more time, technical skills, or organizational slack to devote to setting up bots.

#### Limitations

Our study has a number of important limitations. The sample size of 300 is relatively small. This may explain our relatively large standard errors and some of our null findings. Additionally, our dependent variables represent only the presence of user innovated moderation bots in Discord communities but does not guarantee that the features of the bots are being routinely used. For example, many communities in our sample had multiple bots that performed similar functions which might imply that only one is used. Addition-

ally, the measure for the number of moderators available to us was the number of members with any variation of a “Moderator” role online at the time that we visited each Discord server. We might expect to find different moderators online at other times. Unfortunately, Discord, unlike Reddit, does not have an API that lets users index Discord communities for the number of moderators. Our measure for whether subreddit moderators are present in the Discord community is also limited in that moderation teams for Discord communities are not required to label or make “subreddit mod” roles. It is possible that subreddit moderators could have been present as Discord moderators despite not also being given a “subreddit mod” role. Noisiness in this measure may contribute to our null results for H3.

#### Conclusion

Despite its limitations, our study offers several contributions to existing research on user innovation, community moderation, and the effects of community size. As predicted by Kiene et al., we found evidence that online communities are more likely to adopt user innovated moderation tools when they operate at scale. Extending previous work, we found that the effect of size was strongest for moderation tools that allowed the systematic logging and indexing of moderation actions like warnings and bans. Our results suggest that certain types of work for volunteer moderators, like organizing and managing online communities, may benefit from automation at scale more than others.

#### Acknowledgements

This work was supported by the National Science Foundation (awards IIS-1617129 and IIS-1617468). Feedback and support for this work came from Kirsten Foot, members of the Community Data Science Collective, and from the University of Washington Department of Communication. The manuscript benefited from excellent feedback from several anonymous reviewers at CHI-LBW.

## REFERENCES

- [1] Brian S. Butler. 2001. Membership size, communication activity, and sustainability: A resource-based model of online social structures. *Information Systems Research* 12, 4 (2001), 346–362. DOI: <http://dx.doi.org/10.1287/isre.12.4.346.9703>
- [2] Eshwar Chandrasekharan, Chaitrali Gandhi, Matthew Wortley Mustelier, and Eric Gilbert. 2019. Crossmod: A Cross-Community Learning-based System to Assist Reddit Moderators. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (Nov. 2019), 174:1–174:30. DOI: <http://dx.doi.org/10.1145/3359276>
- [3] Eshwar Chandrasekharan, Mattia Samory, Shagun Jhaver, Hunter Charvat, Amy Bruckman, Cliff Lampe, Jacob Eisenstein, and Eric Gilbert. 2018. The internet’s hidden rules: An empirical study of reddit norm violations at micro, meso, and macro scales. *Proc. ACM Hum.-Comput. Interact.* 2, CSCW (Nov. 2018), 32:1–32:25. DOI: <http://dx.doi.org/10.1145/3274301>
- [4] R. Stuart Geiger. 2014. Bots, bespoke, code and the materiality of software platforms. *Information, Communication & Society* 17, 3 (March 2014), 342–356. DOI: <http://dx.doi.org/10.1080/1369118X.2013.873069>
- [5] Tarleton Gillespie. 2018. *Custodians of the Internet: platforms, content moderation, and the hidden decisions that shape social media*. Yale University Press, New Haven. OCLC: on1005113962.
- [6] Shagun Jhaver, Iris Birman, Eric Gilbert, and Amy Bruckman. 2019. Human-machine collaboration for content regulation: the case of reddit automoderator. *ACM Trans. Comput.-Hum. Interact.* 26, 5 (July 2019), 31:1–31:35. DOI: <http://dx.doi.org/10.1145/3338243>
- [7] Charles Kiene, Jialun "Aaron" Jiang, and Benjamin Mako Hill. 2019. Technological frames and user innovation: exploring technological change in community moderation teams. *Proceedings of the ACM: Human-Computer Interaction* 3, CSCW (Nov. 2019), 44:1–44:23. DOI: <http://dx.doi.org/10.1145/3359203>
- [8] Charles Kiene, Andrés Monroy-Hernández, and Benjamin Mako Hill. 2016. Surviving an “Eternal September”: How an online community managed a surge of newcomers. In *Proceedings of the 2016 ACM Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, 1152–1156. DOI: <http://dx.doi.org/10.1145/2858036.2858356>
- [9] Wanda J. Orlikowski. 1992. Learning from notes: Organizational issues in groupware implementation. In *Proceedings of the 1992 ACM Conference on Computer-supported Cooperative Work (CSCW '92)*. ACM, New York, NY, USA, 362–369. DOI: <http://dx.doi.org/10.1145/143457.143549> event-place: Toronto, Ontario, Canada.
- [10] Wanda J. Orlikowski and Debra C. Gash. 1994. Technological frames: Making sense of information technology in organizations. *ACM Trans. Inf. Syst.* 12, 2 (April 1994), 174–207. DOI: <http://dx.doi.org/10.1145/196734.196745>

- [11] Joseph Seering, Juan Pablo Flores, Saiph Savage, and Jessica Hammer. 2018. The social roles of bots: Evaluating impact of bots on discussions in online communities. *Proc. ACM Hum.-Comput. Interact.* 2, CSCW (Nov. 2018), 157:1–157:29. DOI : <http://dx.doi.org/10.1145/3274426>
- [12] Joseph Seering, Robert Kraut, and Laura Dabbish. 2017. Shaping Pro and Anti-Social Behavior on Twitch Through Moderation and Example-Setting. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. ACM, New York, NY, USA, 111–125. DOI : <http://dx.doi.org/10.1145/2998181.2998277>
- [13] Aaron Shaw and Benjamin Mako Hill. 2014. Laboratories of oligarchy? How the iron law extends to peer production. *Journal of Communication* 64, 2 (2014), 215–238. DOI : <http://dx.doi.org/10.1111/jcom.12082>
- [14] Eric von Hippel. 2016. *Free innovation* (1 edition ed.). The MIT Press, Cambridge, MA.
- [15] Eric von Hippel and Ralph Katz. 2002. Shifting innovation to users via toolkits. *Management Science* 48, 7 (2002), 821–833. <http://www.jstor.org/stable/822693>