

It's Not What You Think: Gender Bias in Information about Fortune 1000 CEOs on Wikipedia

Completed Research Paper

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Abstract

Increasingly, information generated by open collaboration communities is being trusted and used by individuals to make decisions and carry out work tasks. Little is known about the quality of this information or the bias it may contain. In this study we address the question: How is gender bias embedded in information about organizational leaders in an open collaboration community? To answer this question, we use the bias framework developed by Miranda and colleagues (2016) to study bias stemming from structural constraints and content restrictions in the open collaboration community Wikipedia. Comparison of Wikipedia profiles of Fortune 1000 CEOs reveals that selection, source, and influence bias stemming from structural constraints on Wikipedia advantage women and disadvantage men. This finding suggests that information developed by open collaboration communities may contain unexpected forms of bias.

Keywords: Wiki, information quality, open collaboration community, bias, digital media, peer-to-peer production, user-generated content, information digitization, gender differences, CEO

Introduction

Widespread diffusion of online open collaboration communities has revolutionized the way individuals and organizations create and consume information (Kane et al. 2014; Levine and Prietula 2014). These communities facilitate open collaboration among diverse groups of stakeholders who engage together in generating and disseminating information about organizations and organizational leaders. These communities have also created new challenges for those seeking to interpret or manage information about an organization and/or organizational leaders. In particular, open collaboration communities facilitate increased networking amongst stakeholders with competing goals and perspectives, give a platform for critical voices to speak against organizations and organizational leaders, and reduce organizational

control over how information about the organization and organizational leaders is framed (Hatch and Schultz 2002).

Little is understood about the quality of this information, however, such as ways in which bias may be embedded in content (Kane and Ransbotham 2016). While digital media were looked upon with skepticism in the Internet's infancy, open collaboration communities such as Wikipedia have slowly won the trust of the public (Kittur et al. 2008). Given that Wikipedia has been referenced in important documents such as hundreds of court briefs (Gerken 2010), scientific journals (Nielsen 2007), and news stories (Lih 2004), it is clear that Wikipedia has risen in status to a point that information found on Wikipedia is trusted by many, including professionals engaged in work tasks and public officials in powerful positions of authority. Thus, it is of consequence what types of bias exist, and to what extent these types of bias exist, in information created by open collaboration communities.

Prior research in this arena has uncovered evidence of gender bias against females in information generated by open collaboration communities (Limey 2010; Reagle and Rhue 2011; Wagner et al. 2015), but theoretical explanations around how and in what contexts gender bias against females gets embedded in information are lacking. Therefore, the field of information systems is able to offer little guidance for organizational stakeholders trying to understand what types of bias to look for in information about organizational leaders online. In response to this gap in understanding, the following research question is addressed: How is gender bias embedded in information about organizational leaders in an open collaboration community? To study this question, we examined the open collaboration community Wikipedia using the bias framework developed by Miranda and colleagues (2016). Wikipedia profiles for female Fortune 1000 CEOs were compared to profiles for male Fortune 1000 CEOs. Understanding of bias in information about CEOs has practical value given that CEO reputation can affect things like organizations' legitimacy and stock price.

Our investigation revealed differences in bias stemming from structural constraints, though no differences in bias stemming from content restrictions were observed. We found the information in this open collaboration community was biased in favor of women in terms of information creation and presentation. Counterintuitively, in the context of Fortune 1000 CEOs, gender bias on Wikipedia advantages female organizational leaders and disadvantages male organizational leaders. That is, profiles for female Fortune 1000 CEOs are edited more frequently and by a greater number of editors, sourced more thoroughly and with a richer variety of sources, and paid more attention by readers than profiles for male Fortune 1000 CEOs. These findings compliment recent research which found that some common types of information bias are less likely to be observed in information diffused through digital media (Miranda et al. 2016). The finding that females - often disadvantaged by bias in business contexts - were not disadvantaged by bias in information generated by an open collaboration community offers hope that such information is, at least in some contexts, not subject to traditional types of bias. However, the finding that the majority group (i.e., males) were disadvantaged by bias in this context suggests that consumers of information generated by open collaboration communities and diffused through digital content should be vigilant against unexpected forms of bias.

Literature Review

Gender Bias

Research has documented gender bias against females in male-dominated fields such as politics (Lawless 2009), journalism (Eastman and Billings 2000), and athletics (Higgs et al. 2003). In business, barriers for women are so pervasive that the phrase "glass ceiling" was coined as a metaphor for the "transparent barrier which prevents women from moving up the corporate ladder past a certain point" (Oakley 2000, p. 321). In fact, women comprise only around 5% of the 2015 Fortune 1000 CEOs. Even when women do break through the glass ceiling to become CEO, they often face unique challenges relative to their male peers. These challenges too have been described by scholars using a metaphor; "glass cliffs" describe the phenomenon wherein "women may be being preferentially placed in leadership roles that are associated with an increased risk of negative consequences" as a company board decides to take a chance on a nontraditional CEO given a precarious and often desperate situation (Cook and Glass 2014; Ryan and Haslam 2005, p. 83).

Although societal attributions of competence and expectations of gender roles in the public versus domestic sphere have evolved throughout American history, some underlying assumptions and biases remain (Martin 1990). Subtle cues embedded in information are interpreted by individuals and used to create impressions of organizations and organizational leaders (Winter et al. 2003). When individuals are presented with information containing gender bias, the bias embedded in the information not only colors the individuals' perceptions of the focal topic, but also becomes a subconscious frame which is applied in other contexts (Eastman and Billings 2001). Discrimination faced by female entrepreneurs seeking business loans (Fay and Williams 1993), female job applicants (Goldin and Rouse 2000), and female employees during performance evaluations (Bohnet et al. 2016) and compensation negotiations (Mohan and Ruggiero 2003) demonstrates the real life consequences of gender bias. These consequences extend beyond personal implications for CEOs. Organizations with female CEOs can also be disadvantaged by discrimination because shareholders are often less willing to pay top-dollar for shares in female-run corporations (Lee and James 2007).

Digital Media Bias

Decades of systematic study have revealed bias in information diffused through traditional media. Such bias often perpetuates the interests of power holders and enforces the status quo (Markus 1994). While information may be intentionally infused with bias toward the goal of shaping public consciousness (Althusser 2001), bias often creeps in without intent by content creators (Graber 2010). Unintentional forms of media bias stem not only from the subconscious minds of content creators, but also from media features that facilitate or inhibit unbiased content generation. Media are theorized to shape the structure (how content creators interact) and content (what content creators say) of information in ways that contribute to or reduce bias (Miranda et al. 2016).

Drawing from the literature on mass communication and media studies, IS scholars developed a framework for assessing information bias (Miranda et al. 2016). This framework depicts two sources of unintentional bias: structural constraints and content restrictions imposed by media. Structural constraints are barriers to authorship, sourcing and citing of information, and how much influence is garnered by information relating to minority cases or opinions. Content restrictions are barriers to objectivity and truth.

Increases in structural constraints are associated with higher levels of *selection bias*, *source bias*, and *influence bias* (Miranda et al. 2016). Selection bias occurs when there are systematic differences in which individuals, stories, or events are selected for media coverage. Omission of information relating to specific groups indicates selection bias. Source bias occurs when there are systematic differences in the quantity or quality of sources from which information is constructed. Source bias is indicated by the presentation of information without sources, with few sources, or with one-sided, similar sources. Influence bias occurs when there are systematic differences in the degree to which information shapes public consciousness. Distinct from participation or citation, influence is only achieved when information is accessed and used by the public.

Increases in content restrictions are associated with higher levels of *content bias* (Miranda et al. 2016). Content bias is complex and can take a variety of forms. In particular, content bias is indicated when rhetorical devices are used to promote specific, value laden interpretations of information. The salience and effectiveness of such rhetorical devices is enhanced through elements such as images, metaphors, catchphrases, or emotional language (Miranda et al. 2016; Young et al. 2013).

Examination of the framework for assessing information bias in the context of public discourse revealed that digital media imposed fewer structural constraints than traditional media, yet imposed greater content restrictions than traditional media (Miranda et al. 2016). Notably, lean digital media (such as Wikipedia) were found to impose fewer structural constraints, yet greater content restrictions, than rich digital media (Miranda et al. 2016).

Absence of bias is reflected in parity across groups. Departures from parity across groups suggests bias, which necessarily advantages certain groups while disadvantaging others.

Wikipedia – An Open Collaboration Community

An open collaboration community is a “system of innovation or production that relies on goal-oriented yet loosely coordinated participants who interact to create a product (or service) of economic value, which they make available to contributors and noncontributors alike” (Levine and Prietula 2014, p. 1416). Wikipedia, a free online encyclopedia, has been touted by scholars as a rich context for investigation of the consequences of open collaboration (Kane and Ransbotham 2016). Individuals contribute to Wikipedia for a variety of reasons including: contributing is fun, to feel like a part of something, to help their business or career, to gain insights or perspective, to feel needed, and/or they are driven by ideology or values (Nov 2007). As in many open collaboration communities, demographics of content creators on Wikipedia do not reflect demographics of society. Rather, most editors on Wikipedia are Caucasian males (Collier and Bear 2012). For this reason, Wikipedians have acknowledged the potential for bias against less represented demographic groups such as women and have taken steps to counter systematic bias and cultural perspective gaps by creating WikiProjects devoted to consciously promoting subjects and points of view that are traditionally marginalized (Reagle and Rhue 2011). Such efforts are undertaken to promote information quality on Wikipedia.

Prior research outlines two streams of research examining information quality on Wikipedia – collaboration and content (Kane and Ransbotham 2016). The stream of research geared toward understanding collaboration on Wikipedia examines how content creators’ actions and interactions influence information quality (e.g., Kittur and Kraut 2008; Kitter et al. 2009). For example, one study found that content creators fulfill specific roles in the information generation process. One such role is that of a gatekeeper, that is, someone who selects a specific article for which to serve as a defender against bias or vandalism with the goal of promoting information quality (Kane et al. 2014). The stream of research focusing on content tends to examine how article attributes (e.g., article length and the number of images appearing within each article) correspond with information quality (e.g., Blumenstock 2008; Stvilia et al. 2008).

Though less attention has been paid to systematic differences in information quality across Wikipedia articles, prior research has found that only 19.3% of Wikipedia profiles featured women as opposed to 29.9% of biographies in an online biographical database (Limey 2010), indicating potential selection bias against women on Wikipedia. As a follow up, researchers systematically examined profiles for 18,495 individuals listed in the Chambers Biographical Dictionary, which focuses on historical figures from the 18th and 19th centuries, and concluded that the odds of being omitted from Wikipedia were slightly higher for women than for men, but that article length did not differ by gender (Reagle and Rhue 2011). More recently, a study found no evidence of selection bias in information on Wikipedia about women in high profile positions; this same study found evidence of source bias (e.g., female’s profiles were less likely to be cited when the woman was mentioned in another Wikipedia article) and content bias (e.g., female’s profiles were more likely to discuss domestic issues than were male’s profiles, Wagner et al. 2015). While this research provides a starting point for understanding information bias on Wikipedia, a body of research featuring finer-grained examination is needed to explain the nature of bias on open collaboration communities and differences across topics and contexts.

Hypotheses Development

Selection bias against members of minority groups, e.g. women, in information diffused through traditional media has been well documented. For example, minorities tend to be underrepresented in information diffused through historical records, reference works, and encyclopedias (Reagle and Rhue 2011). Selection bias in information diffused through traditional media is often attributed to the concentrated ownership of media platforms and to the power media owners have to silence voices they disagree with (Miranda et al. 2016). Contrary to traditional media, digital media have been found to give voice (Ferguson et al. 2013). More specifically, digital media give voice to the under-represented groups, such as women, that traditional media silence (Deng et al. 2016; Ferguson et al. 2010). In doing so, digital media alter societal power structures such that the narrative of the minority may overpower the narrative of the majority (Yetgin et al. 2012).

At the same time, lean digital media may quiet the voices of those without formal education, whose written contributions to open collaboration communities often lack the refinement and grammatical

astuteness to garner attributions of credibility (Hargittai 2006), empowering educated content creators to set the tone. Higher levels of educational attainment are associated with decreases in expressions of prejudice (Emler and Frazer 1999) and adherence to traditional gender roles, and increases in feminist consciousness and activism on behalf of minorities (Bettencourt et al. 2011). Thus, we expect to find more information relating to the minority group (i.e., female CEOs) than the majority group (i.e., male CEOs) on Wikipedia. We hypothesize that,

Hypothesis 1: Selection bias in information generated by open collaboration communities will advantage the minority group and disadvantage the majority group.

Source bias occurs when content creators cull information from sources which are unreliable and/or reflect a narrow range of values and opinions (Miranda et al. 2016). The most reliable sources (e.g., peer-reviewed journals) are often challenging to digest. Novel sources citing less popular opinions (e.g., niche websites) often feature unreliable information. Consulting a variety of sources in a way that balances the limitations of each requires a great deal of time and effort.

Research suggests that individuals put effort into contributing to open collaboration communities when they find a topic interesting (Reagle and Rhue 2011) and/or are driven by prosocial motivation (Lepore et al. 2011), as is the case for Wikipedians engaging in WikiProjects to end systematic bias against women and other minorities. Thus, we predict that those in the minority group (i.e., female CEOs), as a novelty and the focus on prosocial agendas, will garner more interest and consequent effort resulting in greater numbers of sources and more diverse sourcing. We expect the opposite for those in the majority group (i.e., male CEOs) given the commonness of male CEOs and the lack of precedent from which to base activism around promoting fair representations of men. We hypothesize that,

Hypothesis 2: Source bias in information generated by open collaboration communities will advantage the minority group and disadvantage the majority group.

Information diffused through traditional media is theorized to gain influence or not based on the status of content creators and those about whom content creators choose to write (Lutz 2012). On digital media, however, the content itself has been found to overshadow the status of content creators (Miranda et al. 2016). Digitally diffused information about an individual or topic that is interesting or unique gains the most influence – and may even go viral (Susarla et al. 2012) – while information about less novel topics is ignored (Zuckerman 2014). This pattern can be observed in open collaboration communities such as reddit and 4chan where interesting memes, such as those in the popular “lolcats” series featuring images of cats with systematically misspelled words, have gained tremendous popularity (Miltner 2014). This pattern is also apparent on Wikipedia where the top 25 articles of 2015 featured topics such as movies and celebrities rather than current events or mathematics (Sawer 2016).

While traditional media representations promote standardized views of individuals, digital media are known for cosmopolitan representations (Trenz 2009). Internet culture values individuals who break the mold and stand as examples of individuality. Further, many Internet users surf the Web for the specific purpose of novelty seeking because they enjoy the sensation of discovering something novel (Lin and Tsai 2002). Thus, we expect information about those in the minority group (i.e., female CEOs) to gain influence to a greater extent than information about those in the majority group (i.e., male CEOs). We hypothesize that,

Hypothesis 3: Influence bias in information generated by open collaboration communities will advantage the minority group and disadvantage the majority group.

Despite theoretical support for the notion that information relating to the minority group of CEOs would feature less selection, source, and influence bias than information relating to the majority group of CEOs, theory suggests the opposite should be true for content bias. Traditional media research reveals a longstanding pattern of information bias against minorities, such as women in male-dominated fields (e.g., Falk 2010). Systematic research comparing content bias across media found that content bias problems associated with traditional media were exasperated on digital media, particularly on lean digital media (Miranda et al. 2016). For example, although information diffused through traditional media often emphasizes one perspective or another, multiple perspectives are typically presented; information diffused through digital media, on the other hand, tends to feature only one perspective prominently while peripheral perspectives are drowned out, mocked, or even hijacked by those championing the

prominent perspective (Miranda et al. 2016). This phenomenon is due in part to the low cost of participation in lean collaboration communities where those championing the prominent view can overwhelm contributions from the peripheral group with little effort (Miranda et al. 2016). Media capabilities such as providing anonymity and social distance may also explain the propensity for content bias against minority groups on digital media (Chidambaram and Carte 2004).

Examples of content bias found in open collaboration communities include stereotypical, domestic portrayals of females (Wagner et al. 2015) and differences in emphasis on career controversies across professionals of different nationalities (Callahan and Herring 2011). Thus, we predict information about those in the minority group (i.e., female CEOs) to feature more content bias than information about those in the majority group (i.e., male CEOs). We hypothesize that,

Hypothesis 4: Content bias in information generated by open collaboration communities will advantage the majority group and disadvantage the minority group.

Method

The preceding literature motivates the question: How is gender bias embedded in information about organizational leaders in an open collaboration community? To address this question, we sampled a census of the 50 female 2015 Fortune 1000 CEOs and data for three matched pairs of male Fortune 1000 CEOs: Group 1.) CEOs of firms ranked one level higher on the Fortune 1000 list¹, Group 2.) CEOs of firms ranked one level lower on the Fortune 1000 list², and Group 3.) CEOs in the same industry with the closest rank on the Fortune 1000 list. While one male group would have sufficed to show differences, sampling three groups ensures reliability of the findings. Interim CEOs were not sampled because prior research has established that interim CEOs have different qualities than permanent CEOs (Allgood and Farrell 2003) and interim CEOs are unlikely to transition into permanent CEO positions (Ballinger and Marcel 2010). Thus, researchers generally study CEOs and interim CEOs separately (e.g., Shen and Cannella 2002).

To systematically reveal differences in informational bias found in Wikipedia profiles of female and male Fortune 1000 CEOs, we depict group differences in selection bias, source bias, influence bias, and content bias. For comparisons involving continuous variables, we measure effect size using Cohen's *d*; for dichotomous variables, we use McNemar's test, and for ordinal variables, the sign test is used. Data was collected from Wikipedia directly and indirectly through Wikipedia xtools³, an extension available via Wikimedia Labs. See below for a description of the operationalization of each bias construct.

Selection bias references systematic differences in which information is selected for diffusion and is indicated by missing or incomplete information. Prior research has studied selection bias by looking at whether specific perspectives were consistently addressed or ignored in public discourse (Miranda et al. 2016). In this study selection bias was operationalized in two ways: the number of missing profiles and the word count of existing profiles within the male and female groups. Given that profiles can be published at any time, we also compared profile lifespan.

Source bias references systematic differences in where information comes from. Prior research examining source bias considered whose words were being cited and how information about different perspectives was being culled (Miranda et al. 2016). In this study we looked at how Wikipedia articles were composed and by whom. Source bias was operationalized in the following ways: the total number of edits made to the profile over its lifespan, the total number of major edits made to the profile over its lifespan, and the number of minor / superficial edits made to the profile in its lifespan. Additionally, we examined the percent of total edits made by the top 10% of editors who had contributed to the profile.

¹ This sample included one outlier, Tim Cook, whose page received a great deal of attention due to a controversy surrounding his Wikipedia page. For this reason, we removed Tim Cook and his female pair, Mary Barra, from the comparison of females versus males one rank higher on the Fortune 1000 list.

² In the two cases where one female CEO followed another on the list, males above and below the two females were sampled.

³ <https://tools.wmflabs.org/xtools-articleinfo/>

Operationalizing source bias this way illuminates the extent to which advocates or “gatekeepers” positioned themselves as champions or defenders of the article. Gatekeepers are associated with higher levels of information quality, as they defend articles against inputs that do not fit with the articles or are untrue (Kane et al. 2014). The frequency of edits (i.e., the average number of days between edits) was also used as an indicator of source bias. Finally, the number of editors who contributed information, the number of references cited within the profile, and the diversity of references cited in the profile were used to operationalize source bias. To determine the diversity of references used, we employed grounded theory coding methods following the tradition of Racherla and Mandivwalla (2013). This process revealed 12 higher order codes: academic websites, associations and organizations, books, corporate and information services websites, corporate websites, government websites, industry websites, academic journals, magazines, news agencies and news networks, newspapers, and other. Based on the codes described above, the Blau index (Blau 1977) was used to calculate the diversity of references.

Influence bias references systematic differences in how much traction information gains. Prior research has operationalized influence bias using network metrics to illuminate influence over time (Miranda et al. 2016). While there is no way to know how much the information in each Wikipedia profile influenced the thinking of readers, information cannot be influential without first being consumed by the public. Thus, readership was used as a proxy for influence bias and was operationalized in the following ways: the number of page views in July of 2015 (the month the 2015 Fortune 1000 list was published), total page views from January 1, 2008 to July 31, 2015, and average pageviews per month from January 1, 2008 to July 31, 2015. Among all CEO groups, around 18% had profiles created on or before January 1, 2008 and around 4.6% of profiles were created on or after July 31, 2015. Since no pageview data was available for profiles created after July 31, 2015, those profiles were removed from the sample when influence differences were analyzed.

Content bias references systematic differences in the content of information and involves subjective analysis. Content bias was operationalized using the article’s class rating. This metric is assigned by Wikipedia editors based on a rubric to describe the articles’ quality. Not all articles were ranked. Those articles with ranks in our sample ranged from a low of “Stub-class” to a high of “B-class”. The following are descriptions of the criterion used for relevant quality rankings on Wikipedia (Wikipedia 2016b):

- B-Class: “The article is mostly complete and without major problems, but requires some further work to reach good article standards.”
- C-Class: “The article is substantial, but is still missing important content or contains much irrelevant material. The article should have some references to reliable sources, but may still have significant problems or require substantial cleanup.”
- Start-Class: “An article that is developing, but which is quite incomplete. It might or might not cite adequate reliable sources.”
- Stub-Class: “A very basic description of the topic. However, all very-bad-quality articles will fall into this category.”

Content bias was also operationalized using the total number of images on each profile and the total number of image of the focal CEO on each profile in line with prior research (Miranda et al. 2016).

Findings

The objective of this research was to investigate information bias in the Wikipedia profiles of Fortune 1000 CEOs. Four hypotheses were put forth. First, Hypothesis 1 predicted that selection bias in information generated by open collaboration communities would advantage the minority group and disadvantage the majority group. To determine whether there were systematic differences in selection bias for female versus male CEOs, McNemar’s test was used (Lowry 2016). The findings showed that profile omission among male CEOs was just over 22% more common than among female CEOs. Differences in profile omission were statistically significant for each group, as shown in Table 1.

We then used Cohen’s *d* (Becker 2016; Cohen 1988) to compare the number of words in existing profiles and found a small effect for group 1 and a medium effect for group 3. Though the effect size does not meet the minimum threshold for the comparison of group 2 to the control (female) group, Cohen’s *d* is positive for all comparisons, indicating that profiles for female CEOs contained more words than profiles for male CEOs. See Table 2 for an overview of the effects found when groups were compared using continuous

variables. Taken together, these findings support Hypothesis 1. Not only were profiles for male Fortune 1000 CEOs less likely to exist on Wikipedia, existing profiles for male CEOs contained less information. Notably, comparisons of profile lifespan revealed negative, medium and small effects across all three groups, indicating that the profiles for female CEOs were published more recently than those for male CEOs.

Second, we sought to understand differences in source bias. Cohen's *d* revealed positive, small effects across each group regarding the number of edits made to the profiles. This finding was consistent in terms of total edits, major edits, and minor edits. Positive, small effects were also found when comparing the percent of edits made by the top 10% of editors (e.g., editors championing that page). Negative, medium and small effects were observed across groups for the number of days between edits. That is, profiles of female CEOs were edited more and more frequently than profiles for male CEOs, and were more likely to be edited by a core individual or group. Profiles of female CEOs were also edited by a greater number of editors than profiles for male CEOs, as indicated by the positive Cohen's *d* across groups – though only group 1 had an effect size above 0.2.

Table 1: McNemar's test of differences in omission of profiles for female versus male CEOs

	Control group: female ⁴	Group 1: male+ ¹⁵	Group 2: male- ¹⁶	Group 3: male-i
n	50	47	48	50
Missing	19	29	29	30
Not missing	31	18	19	20
Proportion (pair missing male profile)	1.0000	0.6042	0.6042	0.6000
Proportion (pair missing female profile)	0.3800	0.3750	0.3750	0.3800
Difference (unsigned)	0.6200	0.2292	0.2292	0.2200
Significance (p)	NA	0.0432*	0.0074**	0.0190*
*p<0.05 **p<0.01				

Second, we sought to understand differences in source bias. Cohen's *d* revealed positive, small effects across each group regarding the number of edits made to the profiles. This finding was consistent in terms of total edits, major edits, and minor edits. Positive, small effects were also found when comparing

⁴ The control group contained 50 female CEOs. When Tim Cook was removed from group 1, his pair from the control group, Mary Barra, was also removed for comparisons between the control group and group 1, resulting in n=49 for that set of comparisons.

⁵ Group 1 has n=47 because Tim Cook was removed, and there were two consecutive female CEOs on the Fortune list at ranks 269 and 270, and at the ranks 709 and 710. Thus, the CEOs one rank higher than 269 and 709 did not provide male pairs.

⁶ Group 2 has n=48 because there were two consecutive female CEOs on the Fortune list at ranks 269 and 270, and at the ranks 709 and 710. Thus, the CEOs one rank lower than 270 and 710 did not provide male pairs.

the percent of edits made by the top 10% of editors (e.g., editors championing that page). Negative, medium and small effects were observed across groups for the number of days between edits. That is, profiles of female CEOs were edited more and more frequently than profiles for male CEOs, and were more likely to be edited by a core individual or group. Profiles of female CEOs were also edited by a greater number of editors than profiles for male CEOs, as indicated by the positive Cohen's d across groups – though only group 1 had an effect size above 0.2.

Perhaps the most salient measure of source bias, the number of references also differed across groups. Cohen's d revealed positive, medium and small effects across groups, which demonstrates that more references were used to create content about female CEOs than were used to create content for male CEOs. Positive, medium and small effects across groups also demonstrate that information on female CEO profiles was culled from a greater variety of sources than information on male CEO profiles.

Construct	Operationalization	Group 1: male+1		Group 2: male-1		Group 3: male-i	
		Cohen's d	effect-size r	Cohen's d	effect-size r	Cohen's d	effect-size r
Selection	words in profile	0.6844**	0.3238	0.1508	0.0752	0.3765*	0.1850
	profile lifespan	-0.4940*	-0.2398	-0.4957*	-0.2406	-0.5399**	-0.2606
Source	edits	0.3053*	0.1509	0.2445*	0.1213	0.2559*	0.1269
	major edits	0.3165*	0.1563	0.2386*	0.1185	0.2629*	0.1303
	minor edits (superficial)	0.2612*	0.1295	0.2649*	0.1313	0.2286*	0.1136
	edits made by top 10% of editors	0.3504*	0.1725	0.2584*	0.1281	0.3124*	0.1543
	days between edits	-0.6029**	-0.2886	-0.4067*	-0.1993	-0.5845**	-0.2805
	editors	0.2297*	0.1141	0.1875	0.0934	0.1741	0.0867
	references	0.7148**	0.3365	0.4621*	0.2251	0.2658*	0.1317
	diversity of references	0.4169*	0.2041	0.4770*	0.2320	0.5491**	0.2648
Influence	total pageviews	0.3339*	0.1647	0.2810*	0.1391	0.2485*	0.1233
	average views per day	0.4154*	0.2034	0.3849*	0.1890	0.3456*	0.1703
	views in July 2015	0.2611*	0.1294	0.2459*	0.1220	0.2555*	0.1267
Content	total images	0.1385	0.0691	0.3922*	0.1925	0.0114	0.0057
	images of CEO	0.0290	0.0145	0.4556*	0.2221	-0.0381	-0.0190

*small effect size ($|d| \geq 0.2$) **medium effects size ($|d| \geq .5$)

The second hypothesis posited that source bias in information generated by open collaboration communities would advantage the minority group and disadvantage the majority group. The findings overwhelmingly supported this hypothesis. Cohen's d is used to demonstrate that profiles for female CEOs were edited a greater number of times, more frequently, and by a higher number of editors than profiles for males CEOs. Profiles for female CEOs were also sourced from a greater number of references,

and from more diverse references, than profiles for male CEOs. Given the finding that profiles for female CEOs were created more recently than profiles for male CEOs, these findings are even more salient. That is, profiles for male CEOs have existed longer, yet been contributed to less, and sourced less thoroughly, than profiles for female CEOs.

Third, Cohen's *d* was employed to examine differences in influence garnered by profiles for female versus male CEOs. Across groups, there were positive, small effects demonstrating that profiles for female CEOs were viewed more (total, per day, and in the month the Fortune 1000 list was published) than profiles for male CEOs. These findings provide support for Hypothesis 3, which stated that influence bias in information generated by open collaboration communities would advantage the minority group and disadvantage the majority group. Despite profiles for female CEOs being published more recently than profiles for male CEOs, the profiles for female CEOs garnered more influence than profiles for male CEOs. This finding held true when total views was compared as well as when the average number of views per day and the number of views received in the month of July 2015 were compared.

Finally, Hypothesis 4, which stated that content bias in information generated by open collaboration communities would advantage the majority group and disadvantage the minority group, was not supported. Cohen's *d* was used to check for systematic differences in the total number of images and the number of images of the focal CEO across groups. Though positive, small effects were observed for group 2, no effects were observed for group 1. Further, Cohen's *d* was negative for group 3 and positive for groups 1 and 2 in the comparison of the number of images of the focal CEO. These inconsistent findings do not provide support for Hypothesis 4.

The sign test (Dixon and Mood 1946) was used to compare differences in profile ratings across groups. No evidence of significant differences across groups was found. See Table 3 for an overview of the sign test results. Though no evidence of bias was found, this research alone is not sufficient to lead to the conclusion that no content bias exists, only that bias was not observed in this study.

	Group 1: male+1	Group 2: male-1	Group 3: male-i
z-value	0	0.6547	0.6547
p-value	1	0.4472	0.4472
* $p < 0.05$ ** $p < 0.01$			

Discussion

The study was conducted in order to address the question: How is gender bias embedded in information about organizational leaders in an open collaboration community? Comparisons of Wikipedia profiles for female versus male Fortune 1000 CEOs revealed, unexpectedly, that selection, source, and influence bias on Wikipedia advantaged women and disadvantaged men. Selection bias against males is evidenced by the fact that profiles for male CEOs were significantly more likely to be omitted from Wikipedia than profiles for female CEOs. Among existing profiles, profiles for male CEOs contained fewer words, further indicating selection bias against males.

Source bias against male CEOs is reflected in the low numbers of contributors creating the information on male CEO profiles. Profiles for male CEOs were edited less and by fewer editors than profiles for female CEOs despite profiles for male CEOs having been in existence longer. Profiles of male CEOs also suffered from a lack of championing as gatekeepers tended to focus their efforts on profiles of female CEOs. Source bias was further revealed through the lack of sources used to substantiate the information on profiles of male CEOs. Sources used on male CEO profiles were not only fewer in number, but also tended to be similar and potentially one-sided.

Influence bias, reflected in the number of pageviews each profile received, also disadvantaged male CEOs, whose profiles were ignored by the public relative to profiles for female CEOs. This pattern of profiles for female CEOs garnering more influence than profiles for male CEOs held over time, as well as when only a short period was considered.

Though Hypothesis 4 predicted that content bias would advantage males, no evidence of content bias was found in this study. Article class ratings were similar for profiles of male and female CEOs. Hypothesis 4 was not supported.

This study revealed systematic bias against males on Wikipedia in the profiles of Fortune 1000 CEOs. These findings of an unexpected type of bias (i.e., bias against the majority group) highlight the challenges associated with understanding and predicting which types of bias may exist in information generated by open collaboration communities.

Theoretical Implications

While scholars have a robust understanding of how bias is embedded in information diffused through traditional media, there is much left to be discovered about bias in information diffused through digital media. IS scholars have called for research into how information digitization is affecting the quality of information consumed by the public (Miranda et al. 2016). In this manuscript, we show how Miranda et al.'s (2016) bias framework can be used to study information quality in digital contexts. Our findings provide a foundation which, along with future research, can be applied to develop theories explaining why, how, and when structural constraints and content restrictions lead to bias in collaboratively developed information on digital media.

Notably, we found that bias stemming from structural constraints online may advantage and disadvantage groups in ways opposite of what theory predicts. This finding contributes to theories of digital information quality. Specifically, the finding that despite Wikipedia contributors' demographic makeup being largely Caucasian males, the minority group we sampled benefited from structural constraints while the majority group was disadvantaged by structural constraints. This finding is surprising in light of theories of homophily, which suggest that individuals tend to befriend, work with, and share information with individuals with whom they have much in common (McPherson et al. 2001). It could be inferred that individuals would also write about individuals with whom they have much in common, but our finding to the contrary contributes to understanding of Internet culture as a culture that values novelty, uniqueness, and exceptional cases.

Prior research has used easily observable profile attributes such as word counts and pageviews as indicators of information quality in open collaboration communities; however, this approach has recently come under scrutiny by scholars who demonstrate that information quality is in fact a larger, more complex construct (Kane and Ransbotham 2016). Building on this recent revelation, we demonstrate that profile attributes should not be lumped together as indicators of information quality. Rather, a more nuanced conceptualization of each type of bias that affects information quality is put forth in this manuscript.

Prior research has suggested that the quality of digital information is rooted in platform design (Setia et al. 2013). However, Wikipedia is designed in a way that should reduce or even eliminate bias as information is filtered to fit a template. This process of systematically structuring information should result in formulaic profiles with only minor variations. Yet, this study demonstrates that information found on Wikipedia is neither formulaic nor objective. Rather, information generated by open collaboration communities online may feature unexpected forms of bias even when platforms are designed for uniformity.

Practical Implications

Content created by open collaboration communities is being consumed, and often trusted, by Internet users from all walks of life, including professionals engaging in work tasks (Gerken 2010; Kittur et al. 2008; Lucassen and Schraagen 2010). The findings presented in this manuscript demonstrate that bias embedded in information on Wikipedia may come in unexpected forms. Thus, apparent lack of expected bias should not be relied upon as an indicator of information quality online, whether the source is Wikipedia or other open collaboration communities such as Facebook, Twitter, LinkedIn, or YouTube. Notably, this study revealed bias opposite of that commonly found in traditional media sources, which suggests that individuals may be able to counter the effects of bias in each realm by consulting both digital

information created by open collaboration communities and information created through traditional means and diffused through traditional media. Consulting multiple and varied sources can reduce the effectiveness of biased frames and help individuals evaluate information more objectively (Miranda et al. 2016).

Just as individuals and organizations consuming information generated by open collaboration communities should be wary of information bias, organizations concerned with the portrayals of organizational leaders should monitor open collaboration communities such as Wikipedia as well as other sources of information diffused through digital media. Many open collaboration communities have codes of conduct to which content creators adhere, allowing individuals and organizations to voice concerns about bias. In particular, Wikipedia has talk pages on which organizational members can leave comments for editors and explain their concerns.

Limitations and Future Research

Though this research represents an important early step in understanding of information quality online, it is not without limitations. The operationalization of biases emanating from structural constraints seems fitting in most cases, though influence bias is measured by proxy. Our investigation of content bias lacks the rich insights that qualitative inquiry could provide. While this study did not reveal evidence of systematic content bias, it cannot be concluded from this study that no content bias exists. If content bias exists in profiles of the minority group, for whom decreased influence bias results in greater diffusion of biased content, then decreases in structural constraints might result in a net disadvantage for the minority group. Thus, future research should investigate bias stemming from content restrictions further. Based on the communications and computer mediated communications literature, potential sources of bias include gender bias, cultural bias, and racial bias among others (Chan et al. 2016; Henry and Tator 2002; Kellner 2011).

Apple CEO Tim Cook's Wikipedia profile was excluded from this study due to the increased attention it received when editors scuffled over whether or not Wikipedia was an appropriate locale for "outing" Tim Cook as homosexual. Complex questions arose in Wikipedia's talk pages about whether attributes such as race, religion, and sexual orientation should be mentioned on profiles of CEOs, whose prominence was due to their professional success rather than personal attributes. Content creators' questions about when information adds bias rather than contributing to comprehensiveness merit consideration from scholars. A broader examination of additional types of bias would provide valuable insights of practical value. Some appropriate methods for investigation of content bias include hermeneutics, critical analysis of generative themes, qualitative coding of articles and talk pages, and semantic networks to reveal the underlying structure of words and topics within articles.

Another limitation of this research is the relatively small sample size. Though all profiles for the 50 female Fortune 1000 CEOs were sampled, along with existing profiles for a sample of 145 male Fortune 1000 CEOs, this sample represents only a fraction of the over 5,000,000 English language articles on Wikipedia (Wikipedia 2016a). Much of the research examining Wikipedia has taken advantage of the vast amounts of data Wikipedia provides to conduct large-scale investigations at a macro level (e.g., Mestyán et al. 2013; Ransbotham and Kane 2011). While this sort of macro level view was imperative when understanding of open collaboration community phenomenon was at a nascent stage, now that foundational theories around open collaboration exist, scholars are recognizing the need also for finer-grained examination such as qualitative analysis of single Wikipedia articles (e.g., Kane et al. 2014) or groups of Wikipedia articles (e.g., Xu and Zhang 2013).

A clear gap in understanding exists regarding the antecedents, consequences, and nature of bias in information across groups of articles. Future research should harness the value of big data on Wikipedia to take a closer look at multiple smaller samples with commonalities (e.g., the gender or race of the focal subject) in order to identify patterns in bias across similar groups of information. More research is needed to test these hypotheses among other groups (i.e., entertainers and political leaders) to see under what conditions, and for which minority groups, the pattern of structural constraints disadvantaging the majority group holds. Regardless, the findings presented in this manuscript demonstrate the inadequacy of traditional media theories to predict bias in information found online and suggest that more nuanced views of bias in open collaboration communities are needed.

Conclusion

While individuals and organizations are increasingly consuming, trusting, and basing decisions on information generated by open collaboration communities and diffused through digital media, little is known about the types of systematic bias contained in such information. The objective of this research was to investigate information bias in one context - the Wikipedia profiles of Fortune 1000 CEOs. The findings revealed an unexpected type of gender bias (i.e., bias disadvantaging the majority group and advantaging the minority group). Specifically, the findings revealed systematic differences in selection bias, source bias, and influence bias in information about CEOs of different genders. Profiles of female CEOs were more likely to exist, benefit from editors' efforts and championing, be appropriately sourced, and gain influence than profiles of male CEOs. These unexpected findings demonstrate the potential for unexpected forms of bias in information found online and highlight the need for future research into antecedents and consequences of information bias.

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