

# Voice of the Users: An Extended Study of Software Feedback Engagement

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**Abstract** Many software users give feedback online about the applications they use. This feedback often contains valuable requirements information that can be used to guide the effective maintenance and evolution of a software product. Yet, not all software users give online feedback. If the demographics of a user-base aren't fairly represented there is a danger that the needs of less vocal users won't be considered in development. This work investigates feedback on three prominent online channels: app stores, product forums, and social media. We directly survey software users about their feedback habits, as well as what motivates and dissuades them from providing feedback online.

In an initial survey of 1040 software users, we identify statistically significant differences in the demographics of users who give feedback (gender, age, etc), and key differences in what motivates them to engage with each of the three studied channels. In a second survey of 936 software users, we identify the top reasons users don't give feedback, including significant differences between demographic groups. We also present a detailed list of user rated methods to encourage their feedback.

This work provides meaningful context for requirements sourced from online feedback, identifying demographic groups who are underrepresented. Findings on what motivates and discourages user feedback gives insight on how feedback channels and developers can increase engagement with their user-base.

## 1 Introduction

Software users write online about the applications they use, often reporting issues they encounter or ways they would like the product to improve. These insights are important for development teams as they improve their products to better satisfy their users. Organisations want their products to be rated positively since this can help to grow their user-base [1]. Previous studies have identified requirements information in user feedback on app stores, product forums, and social media [1], [2], [3], [4]. This feedback has been called the "voice of the users", with much recent research studying efficient methods to extract requirement insights (e.g. [3], [5], [6], [7]).

However, not all software users provide online feedback. If online feedback is being used to drive product development decisions, the concerns and desires of only the vocal users are being considered. If the demographics of the vocal users are not representative of the overall set of users, this introduces the possibility of developing biased software that does not meet the needs of all users. Therefore, it's important to understand which software users do give online feedback and, in doing so, identify groups whose views may be underrepresented.

Yet, very little research has investigated who is giving online feedback for software products with respect to the demographics of the users. This may be due to the fact that demographic information of feedback givers is not readily available. On some feedback channels, even the full name of the person providing the feedback is unavailable. Some preliminary studies have investigated the gender and geographic location of users providing feedback on app stores [8], [9]. These studies found that men were more likely than women to provide feedback on the Apple app store. However, these results are obtained by approximating gender based on usernames, since actual gender identity of the feedback givers is not available on app stores.

In this study, we overcome the online data sparsity problem by directly surveying software users about their feedback giving habits. In an initial survey, 1040 software users were asked about their feedback giving habits on three popular channels: app stores, product forums and social media [1]. Information on users demographics and

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<sup>1</sup> App stores comprise typical sources of apps, such as the Apple app store, or the Google Play Store, where users can provide written feedback and star ratings for apps. Product forums are websites separate from store pages and devoted to specific products

software use were also collected, allowing for the examination of feedback habits across multiple demographics categories (gender, age, education), finding significant differences in the gender and age of feedback givers. We also investigated what motivates feedback givers and if their software usage habits relate to their feedback giving habits.

In a second survey, 936 software users were asked about the reasons they choose not to give feedback when they face software issues, and potential ways they could be encouraged to give feedback. Again, demographic information was collected from respondents, allowing the analysis of differences in feedback behaviour between demographic groups.

Our study was guided by the following research questions:

**RQ1:** *What are the demographics of software users who report to give online written feedback?*

**RQ2:** *What motivates software users to give online feedback and are there differences across demographics?*

**RQ3:** *When software does not meet expectations, what are the reasons users decide not to give online feedback?*

**RQ4:** *What new methods are perceived to increase the likelihood of software users giving online written feedback?*

**RQ5:** *Does the likelihood of giving online written feedback vary based on the type of software used and the duration of software usage?*

The contributions of this paper are insights about which software users give online feedback, what motivates users when they give feedback, and what discourages them when they don't. Specifically: (1) We show that there are differences in the feedback habits of software users based on traditional demographics. For gender, men reported giving more written feedback than women. With age, distinct patterns emerged with respondents between 35 and 45 reporting to give the most written feedback on all channels.

(2) We show that user groups have different motivations to give feedback and these motivations vary across each of the three feedback channels. Respondents also reported differences in the success of in-app prompts between eliciting app ratings and written feedback, and differences in the frequency individual feedback givers write on app stores, product forums and social media.

(3) We present a detailed list of the top reasons users don't give online feedback. We found the top three reasons to be the same across all three study channels, namely: Looking for an existing answer instead, finding an alternative app instead, and feeling a resolution would take too long. However, there are significant differences in the reasons not to give feedback between channels, between men and women, and between age groups.

(4) We examined user perceptions on new methods to encourage online feedback. We found that users are more encouraged by potential incentive based elicitation methods such as in-app rewards, compared to possible alternative feedback options like through a smart assistant or audio recording. However, many respondents still agreed that alternative options could encourage their feedback.

(5) We present evidence that software users feedback habits also vary with respect to the way they use software. Respondents who spend more hours each day on their phone or computer report giving more written feedback about the software they're using. The software platform being used also has a relationship to written feedback rates, with Linux (computer) and Android (phone) users reporting to give more feedback than those using other platforms.

Our findings provide valuable context for requirements elicited from online feedback, identifying underrepresented user demographics. Findings on what motivates and discourages user feedback gives insight into how feedback channels and developers can increase engagement with their user-base.

This paper provides a significant extension over our previous conference publication [10]. This paper extends the initial study by: 1) investigating the reasons users don't give online feedback when software doesn't meet their expectations (RQ3), and 2) studying new methods to encourage user feedback (RQ4). These additional questions were investigated through a second survey, that was completed by 936 respondents across several countries. This new data and its analysis led to two new contributions (contribution numbers three and four described above). Based on the insights from these new findings, the implications discussed in section 5 have been expanded from those appearing in the conference paper. Namely, two of the implications have been expanded (relating to mechanisms to encourage feedback and eliciting feedback through prompts) and a new implication related to motivating user feedback has been added. In addition to these two major new contributions, we also provide additional extensions to the initial study. From the first survey, open-ended responses have been manually coded and additional motivations to give app store feedback have been identified and reported. Further, the related work has been extended with a third sub-section to encompass the new areas of investigation.

The paper is structured as follows: Section 2 reviews the related work that informed our research. In section 3 we present our research methodology. The results are presented in section 4 and discussed in section 5 including a discussion on the threats to validity. Finally, section 6 concludes the paper.

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or companies. Social media include outlets such as Facebook, Reddit, Instagram, and allow users to comment and share feedback without special moderation, oftentimes on dedicated company pages.

## 2 Related Work

### 2.1 User feedback in requirements engineering

Researchers have found requirements relevant information in feedback on several prominent online channels, including: app stores, social media, and product forums [1], [3], [4]. These channels can contain large volumes of valuable information. Pagano and Maalej [1] found that approximately a third of user reviews on app stores contain information related to software requirements.

User feedback that contains bug reports or feature requests (and more) can be used by developers to address the needs and desires of their users which is critical to the ongoing success of their software.

Manually eliciting software requirements from online feedback can be extremely time intensive due to the large volumes and varying quality of text language that comes from highly distributed user-bases [11]. Requirement elicitation can be further complicated when it is part of a software ecosystem, a growing trend in the software landscape [12]. In an ecosystem the line between products can be blurred and different integrations must also be considered. Much recent research has investigated methods to automatically mine requirements in user feedback on app stores, Twitter and product support forums [2], [3], [5], [6], [7], [13], [14], [15], [16].

### 2.2 Demographics of software user who give feedback

There has been limited research to understand which software users give online feedback and what motivates them. Guzman et al. [8] looked at the difference between men and women who give feedback on the Apple app store. They manually approximated the gender of each person leaving a written review based on their username. They found a slight majority (57%) of the reviews were written by men. However, there were differences in this ratio when geographic region was considered. For example, in India 83% of feedback givers were men. In Australia, women wrote the majority (67%) of the reviews. They did not find any statistically significant differences in review sentiment, content, and rating between genders.

Another study investigated differences in feedback from the Apple app stores of eight countries [9]. This study found that feedback characteristics such as sentiment, content, rating, and length significantly varied between the countries.

These studies were both limited to the Apple app store. In addition, since demographic information like gender is not available for app store users, gender was only approximated and other demographics like age could not be studied. This study provides a more thorough investigation into demographics of feedback givers across three prominent types of online feedback channels (app stores, product forums, and social media).

### 2.3 Motivating software user behaviour

Our previous work [10] presented evidence that the majority of software users don't give online feedback. Additionally, it showed certain demographics of users may be underrepresented in feedback, raising questions about how representative this feedback is of the complete user-base. In this extended study we investigate potential new methods to encourage software feedback, looking at incentive based methods, as well as alternative ways to give feedback.

In recent years, incentivised crowd-sourced data acquisition has become popular. Platforms like Amazon's Mechanical Turk use relatively small financial incentives to elicit crowd generated data in tasks such as machine learning labelling and research survey's [17]. Software users are also highly motivated by digital goods, with an excess of \$15 billion of in-application spending reported in 2016 [18]. Previous work has investigated the different motivations users have to acquire digital goods finding game progression, customisation, effort expectancy and social factors to be highly motivating [19]. In our work we surveyed software users, finding that they would also be highly motivated by financial and digital incentives in the context of online software feedback.

We also investigated alternative feedback options as potentially encouraging software feedback. In a study of Smart Home feedback elicitation, Stade et al. [20] found that users reported to be enthusiastic to give feedback, however the actual (real world) rate of feedback was low. The study identified that alternative feedback methods such as audio and smart assistant facilitation may encourage feedback compared to traditional methods. Following this work, we surveyed general software users on the potential of alternative methods to encourage their feedback.

## 3 Methodology

To answer our research questions, we conducted two survey's of software users, asking about their feedback habits on three channels; app stores, forums and social media. An initial survey was conducted in December

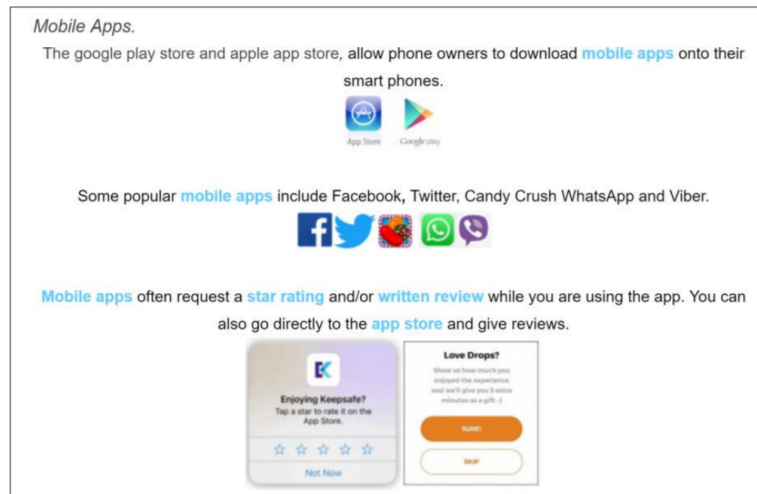


Fig. 1 Survey mobile app and app store descriptions



Fig. 2 Survey support forum description

2019, investigating if reported feedback habits and motivations differed across demographics ( $RQ1$ ,  $RQ2$ ,  $RQ5$ ), receiving 1040 complete responses.

A second survey was undertaken in November 2020, extending the initial work, investigating the reasons software users don't give online feedback ( $RQ3$ ) and looking at ways to encourage feedback ( $RQ4$ ). This second survey received 936 complete responses.

### 3.1 Survey Design

**First Survey:** The original survey consisted of 24 multiple-choice questions in five main sets, as shown in Table 1. The first three sets of questions asked about the feedback the participant provides in the three feedback channels under investigation: app stores (Q1-5), social media (Q6-9), and product forums (Q10-13). The remaining two sets of questions collect software usage information (Q15-18) and demographic information (Q19-24). Descriptions of what was meant by app store and product forum feedback were given within the survey to help participants understand the question context, shown in figures 1 and 2. Questions eliciting details on feedback habits were asked before software usage and demographic questions to highlight the purpose of the study and to maintain participant interest.

The sets of questions on the three feedback channels each follow the same general format. First, the participant is asked if they have given feedback on that channel. Next, if applicable, they are asked how frequently they give feedback, the type of feedback given (e.g. reporting a bug), and their motivation for providing feedback on this channel. These questions were all multiple choice. The answer options for the type of feedback provided and the motivation for providing feedback were based on findings from recent research studies on each of these feedback channels. The participants were also asked about their perceptions on the impact of their feedback on influencing changes in the software products (Q14).

For some questions, participants could select more than one answer choice (e.g. motivation for giving feedback). The full list of questions and answer choices is shown in Table 1. Abbreviated answers for each question are given in the table, an unabbreviated copy of the survey can be found on Zenodo 2.

<sup>2</sup> <https://zenodo.org/record/3674076#.XkxNFygzZPY>

The software usage questions asked participants how they interact with software products including the types of devices they use, the types of software they use, and the hours spent on devices each day. The answer choices for the types of software were obtained from the categories of apps on popular app stores.

The demographic questions collected information on the participants age, gender, ethnicity, education, and employment. These questions and their associated answer choices were informed by traditional marketing demographic categories [21] as well as the New Zealand census (2018) [22].

**Second Survey:** Analysis of the initial survey showed overall low feedback rates, with underrepresented demographic groups. This prompted a second follow up survey, with the goal of understanding why users often don't give feedback and how they could be better encouraged to in the future.

For the second survey, four new multi-choice questions (EQ1-4) (see Table 2) were added to the first survey's demographic and software usage questions. The new questions were placed before the demographic and usage questions to highlight the focus of the survey and encourage engagement. The full second survey has been made available on Zenodo<sup>3</sup>

The first three questions (EQ1-3) are focused on reasons not to give online feedback (RQ3), asking about each of the three study channels. As this is a new area of software engineering research, there wasn't existing literature to draw on for answer options. The options for EQ1-3 were primarily sourced from the first survey in-person collection. Participants frequently gave reasons they didn't give feedback, when asked about their feedback giving habits, including (Table 2: *option a*) I wasn't aware I could influence improvements, *b*) it would take too long for a resolution, *d*) it wouldn't lead to a resolution, *e*) I'd find an existing answer instead, *f*) I'd find an alternative app instead. For *option c*, "*The essential guide to user interface design*" [25] says confusing interface elements, such as confusing layout or navigation, will quickly lead to user abandonment. Finally, *option g* was given as an inverted option from the two first survey motivations, of recommending or discouraging other users from downloading software, which was cited as motivating by many respondents.

The fourth extension question (EQ4) is focused on new methods to encourage user feedback (RQ4), across all study channels. This question gives five multi-choice answers, three new methods to give feedback and two reward types to incentivise feedback. The three new methods to give feedback (audio recording, smart assistant, video recording) were sourced from and inspired by Stadel et al's work on smart home feedback [20].

The reward incentive options are a (small) financial reward and in-app rewards such as in-app currency or digital items. Financial incentives have been used effectively in recent years to elicit crowd sourced data, on platforms such as Amazon's Mechanical Turk [26]. In-app or digital items have shown to have real-world value. Many modern games offer market places where users exchange billions of dollars for digital items [18], suggesting digital incentives may also be effective for software feedback.

### 3.2 Ethics Approval

Both survey's had ethics approval from the University of Auckland's Human Participants Ethics Committee.

### 3.3 Recruiting Participants

We used convenience sampling for both surveys to recruit participants [28]. We selected convenience sampling for its usefulness for engaging a high number of participants in a reasonable time period. The possible sources of bias from our sampling methodology are discussed in section 5.1. As incentive for survey participation, we offered each participant a chance to join a raffle to win a \$200/€120 cash prize. The survey was primarily made available online through the Qualtrics survey platform [29].

**First Survey:** The authors (and their colleagues) shared a link to the Qualtrics survey on Facebook and Twitter. In addition, we recruited from a pool of university participants using the hroot software [30]. The pool includes nearly 3500 participants who registered online to be invited to and participate in scientific studies, either on-site or online. This pool was mainly advertised at the Karlsruhe Institute of Technology, so the pool primarily contains students between the ages of 18 and 30. Through hroot, 2570 participants were invited. Hardcopies of the survey were also distributed in public areas of Auckland city, during December 2019. The completed hardcopy survey responses were manually consolidated with the online survey responses. The survey was open to anyone 16 years or older.

**Second Survey:** The second survey was also hosted on Qualtrics. Once again, participants were contacted through the hroot software pool, recruited from the Karlsruhe Institute of Technology. Additionally, participants from the first survey, who indicated they would like to receive the study results, were invited to participate in the second survey, when the results were sent. About 1300 participants were invited through hroot for the second survey.

<sup>3</sup> <https://zenodo.org/record/4320164#.X9beD9gzZ3g>

Table 1 First Survey Questions

Question	RQ	Topic	Question	Answer Source
Q1.	All	App store	What review types have you given to mobile apps in the past? (choose all that apply) (None / Prompted rating / Prompted written review / Direct rating / Direct written review)	-
Q2.	RQ2	App store	How many times have you given mobile apps you use a star rating in the last year? (None / 1-4 times / 5-12 times / 13-26 times / 27-52 times / 53 or more times)	-
Q3, 7, 11.	All	App store (Q3), Product forum (Q7), Social media (Q11)	How many times have you written (or given a review) on <b>this channel</b> in the last year? (None / 1-4 times / 5-12 times / 13-26 times / 27-52 times / 53 or more times)	-
Q4, 8, 12.	RQ1	App store (Q4), Product forum (Q8), Social media (Q12)	What types of posts (or reviews) have you written about software (or apps)? (choose all that apply) (Praise (all channels) / Report bug (all channels) / Request feature (all channels)) / Ask a question (all channels) / Recommend to others (app stores, social media) / Dissuade others (app stores, social media) / Discuss shortcoming (app stores, social media) / Dispraise or criticise (app store, product forum) / Discuss a helpful situation (app stores) / Discuss specific feature (app stores) / Assist others (product forums) / Other, please specify (all channels))	Q4 [1] Q8 [3] Q12 [4]
Q5, 9, 13.	RQ2	App store (Q5), Product forum (Q9), Social media (Q13)	What was your motivation(s) to write on <b>this channel</b> in the past? (choose all that apply) (Show appreciation / Show dissatisfaction / Influence improvement / Recommend / Discourage others / Connect or socialise about software / No specific motivation / Other, please specify)	Q5 [1] Q9 [3] Q13 [4]
Q6.	All	Product forums	How have you used software product forums in the past? (choose all that apply) (I haven't / Reading and viewing / Written posts)	-
Q10.	All	Social media	Have you used social media (E.g. Twitter, Facebook) to discuss software products you are using? (choose all that apply) (I haven't / Reading and viewing / Written posts)	-
Q14.	RQ2	App store, Product forum, Social media	How likely do you think it is for an app/software product to change based on your online reviews? (Definitely will / Probably will / Might or might not / Probably won't / Definitely won't)	[23]
Q15.	RQ3	Software usage	What type of mobile phone do you currently use? (choose all that apply) (iPhone / Android (E.g. Samsung, Pixel) / I don't use a mobile phone / Other, please specify)	-
Q16.	RQ3	Software usage	What type of computer do you currently use? (choose all that apply) (Windows / Mac (Apple) / Linux / I don't use a computer / Other, please specify)	-
Q17.	RQ3	Software usage	How many hours per day do you use your phone? (Less than 1 hour / 1-4 hours / 4-8 hours / More than 8 hours)	-
Q18.	RQ3	Software usage	How many hours per day do you use your computer? (Less than 1 hour / 1-4 hours / 4-8 hours / More than 8 hours)	-
Q19.	RQ1	Demographics	Do you work or have you previously worked in the software industry? (No / I work or have worked in software / Other, please specify)	-
Q20.	RQ1	Demographics	How old are you? (Under 18 years old / 18-24 years old / 25-34 years old / 35-44 years old / 45-54 years old / Over 55 years old)	[22]
Q21.	RQ1	Demographics	What is your gender? (Man / Woman / Prefer not to say / Prefer to self-specify (please specify))	[22]
Q22.	RQ1	Demographics	What is your ethnicity? (White (European) / Asian / Pacific people / African / Middle Eastern / Latin American / Other, please specify)	[22]
Q23.	RQ1	Demographics	What is your highest level of education completed? (Secondary school / Post secondary, Vocational training / 1-2 year tertiary education / Bachelor degree (3-4 years) / Master degree (postgraduate), Doctoral (postgraduate) / Other, please specify)	[24]
Q24.	RQ1	Demographics	What is your current employment status? (Employed full-time (> 40 hours) / Employed part-time (< 40 hours) / Currently unemployed / Student / Retired / Self-employed / Unable to work / Other, please specify)	[22]

**Table 2** Second Survey Questions

Question	RQ	Topic	Question	Answer Source
EQ1-3	RQ3	App store (NQ1), Product forum (NQ2), Social media (NQ3)	<i>Please rate your <b>agreement level</b> with the following statements:</i> In the past, when an app/software didn't meet my expectations, I've chosen not to write a review/post because, a) I wasn't aware I could influence app/software improvements by writing a review/post b) I thought it would take too long to get a resolution with a review/post c) I've found <i>this channel</i> confusing or hard to use d) I didn't think an app/software review/post would be seen by developers or lead to a resolution e) I would look for an existing answer online instead of writing a review/post f) I would look for an alternative app/software instead of writing a review/post g) I didn't think my review would influence other app/software users h) Other reason (please specify)	-
EQ4	RQ4	App store, Product forums, Social media	<i>Please rate your <b>agreement level</b> with the following statements:</i> I would be more likely to post on app stores, forums or social media about software issues or requests in the future if, a) I would receive a small financial incentive b) I would receive in app rewards. E.g. game currency c) I could give feedback via audio d) I could give feedback via video e) I could give app feedback through a smart assistant (Alexa, Google Assistant) f) Other (please specify)	27, 26, 20

Furthermore, we recruited new participants for the second survey through Zhejiang University, China. The survey was advertised in Zhejiang University's online student forums (CC98 and Duoduo Xiaoyou.), with respondents being given the chance to win one of several ¥200 prizes, as substitute to the \$200 prize offered in New Zealand and Germany. For the Zhejiang University distribution, the second survey was translated from English to Mandarin by a paid contractor, and was then reviewed by the third author (a native Mandarin speaker), before distribution. The translated survey has been made available on Zenodo<sup>4</sup>. Open-ended responses were translated back to English for analysis by the third author.

### 3.4 Survey Participants

**First Survey:** Across all collection channels, 1040 participants fully completed the survey. All respondents reported having used software on computer or mobile, therefore all respondents are software users. The make up of the survey respondents with respect to gender, age, ethnicity, education and employment are shown in Table 3

Regarding the highest level of education obtained, we noticed that many respondents reported secondary school (411) and bachelor degree (390). Given the hroot software recruited from a pool of university participants, we suspected education level could be associated with the age of the participants. We saw that 90.02% of secondary school educated reported to be under 25, compared to only 41.61% of those who have higher education. After controlling for age, we did not see any significant differences in feedback habits in regard to education level. Thus, we do not report results considering education level.

**Second Survey:** Across all the collection channels, 936 participants fully completed the extension survey. Made up of, 423 respondents recruited through Zhejiang University, 420 respondents through the Karlsruhe Institute of Technology pool and 93 respondents invited through the first survey follow up. A demographic breakdown of the extension survey respondents is shown in table 3

### 3.5 Survey Analysis

To answer our research questions, we analysed the ratio of respondents in each user group (based on demographics or software usage) that reported a particular behaviour, e.g. giving feedback on a particular feedback channel or having a certain motivation. Chi-squared tests, which tests for differences in proportion between two groups [31], were used to find if differences in reported behaviours between user groups are statistically significant.

Statistical significance (Chi-squared) was calculated for Likert scales answers by considering *strongly agree* and *agree* as a single agreement value. Likewise, *strongly disagree* and *disagree* were combined as a single disagreement value, with neutral values not used in the calculation.

Optional open-ended answers, in addition to the primary closed-ended options, were given for motivation to give feedback (RQ2), reasons not to give feedback (RQ3) and methods to encourage feedback (RQ4). These open ended-responses have been categorised into common themes using Thematic Content Analysis [32], themes are

<sup>4</sup> <https://zenodo.org/record/4320182#.X9bmt9gzZ3g>

**Table 3** Respondent Demographics

Demographic Type	Group	First Survey Respondents	Second Survey Respondents
<b>Gender</b>	Men	571 (54.9%)	500 (53.5%)
	Women	454 (43.7%)	418 (44.7%)
	Gender diverse	16 (1.5%)	18 (1.9%)
<b>Age</b>	Under 18 years	61 (5.9%)	7 (0.8%)
	18 - 24 years	571 (54.9%)	629 (67.2%)
	25 - 34 years	285 (27.4%)	270 (28.9%)
	35 - 44 years	50 (4.8%)	24 (2.6%)
	45 - 54 years	29 (2.8%)	5 (0.5%)
	Over 55	44 (4.23%)	1 (0.11%)
	<b>Ethnicity</b>	White/European	790 (76.0%)
Asian		149 (14.3%)	463 (49.5%)
Middle Eastern		26 (2.5%)	14 (1.5%)
Latin American		24 (2.3%)	13 (1.4%)
Pacific and Maori		18 (1.7%)	3 (0.3%)
African		7 (0.7%)	7 (0.7%)
Other		27 (2.6%)	21 (2.2%)
<b>Education</b>		Secondary school	411 (39.5%)
	Vocational Training	14 (1.4%)	6 (0.6%)
	1-2 year Tertiary	62 (5.9%)	18 (1.9%)
	Bachelor degree	390 (37.5%)	515 (55.0%)
	Master degree	129 (12.4%)	183 (19.6%)
	Doctoral degree	25 (2.4%)	25 (2.7%)
	Other	9 (0.9%)	5 (0.5%)
	<b>Employment</b>	Full time (> 40 hours)	215 (20.7%)
Part time (< 40 hours)		78 (7.5%)	35 (3.7%)
Student		644 (61.9%)	750 (80.1%)
Self-employed		28 (2.7%)	5 (0.5%)
Currently unemployed		39 (3.8%)	10 (1.1%)
Retired		15 (1.4%)	2 (0.2%)
Unable to work		4 (0.4%)	0 (0.0%)
Other		18 (1.7%)	15 (1.6%)

presented with a typical example and the quantity of responses in the theme. The thematic content analysis was conducted by the first author through discussions and iterations with another author.

With respect to gender, the majority of participants identified as men or women. We did give participants the option to self-specify gender, however too few participants chose this option in order to find statistically significant results. Thus, our analysis was limited to only the differences between participants who identified as men and women.

## 4 Results

### 4.1 Demographics

**RQ1:** *What are the demographics of software users who report to give online written feedback?*

In this section we present the percentage of *written* feedback givers in each demographic group.

**Feedback across online channels:** Overall, 30.96% of survey respondents reported having written feedback, on any of the three online channels. The most survey respondents reported having written feedback on app stores (18.16%), then on product forums (13.45%) and least on social media (7.11%). The majority of feedback giving respondents gave feedback to only one channel (77.64%), 19.57% had written on two channels, with 2.80% writing on all three (Fig. 3). A Chi-squared test showed the higher rate of respondents using only one feedback channel over multiple channels is statistically significant ( $p < 0.001$ ).

**Age:** Under 18's, reported to have given the least feedback of all ages, across all channels (*app store 6.6%, forums 0.0%, social 4.9%*) (Fig. 4).



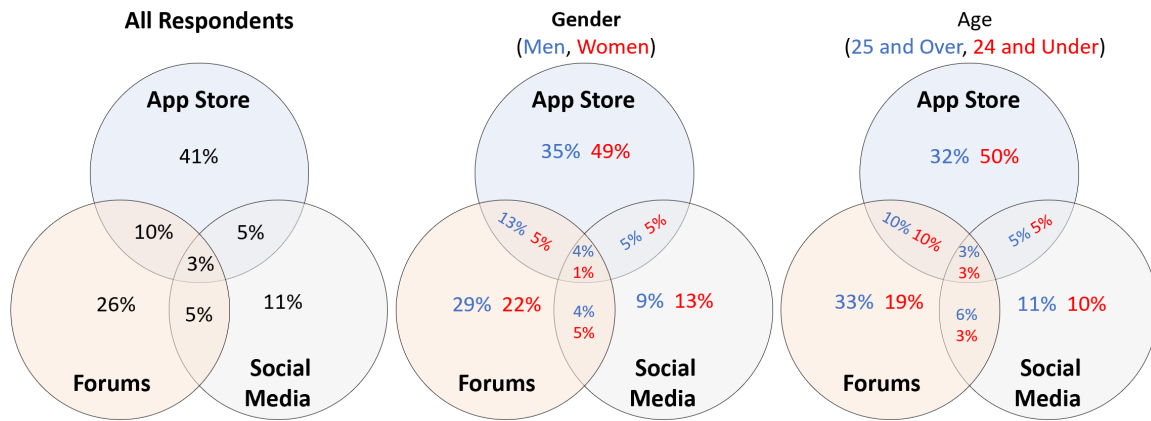


Fig. 3 Feedback given to each online channel, as a proportion of respondents who had given online written feedback.

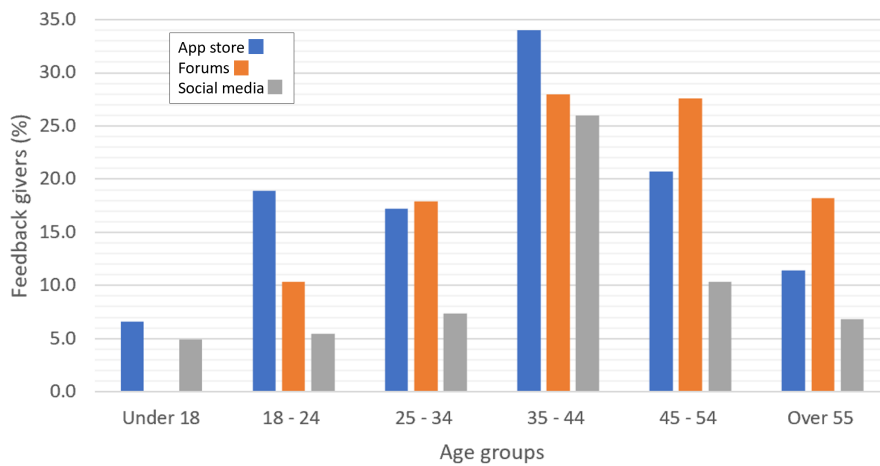


Fig. 4 User feedback with age

Table 4 Comparing app store and forum feedback with age

	App Store (%)	Product Forums (%)
Under 25 years old	<b>17.72</b>	<b>9.34</b>
25 years old and over	18.87	19.85

Table 5 User feedback with age, Significance Tests

Compared Age Groups	App Store		Product Forums		Social Media	
	Chi2	p	Chi2	p	Chi2	p
Under 18 < 18 - 24	<b>4.96</b>	<b>0.026</b>	<b>5.79</b>	<b>0.016</b>	0.017	0.896
Under 18 < 25 - 34	3.600	0.058	<b>11.419</b>	<b>0.001</b>	0.165	0.685
Under 18 < 35 - 44	<b>11.760</b>	<b>0.001</b>	<b>17.087</b>	<b>&lt; 0.001</b>	<b>8.264</b>	<b>0.004</b>
18 - 24 < 25 - 34	0.27	0.603	<b>9.04</b>	<b>0.003</b>	0.936	0.333
18 - 24 < 35 - 44	<b>5.603</b>	<b>0.018</b>	<b>12.183</b>	<b>&lt; 0.001</b>	<b>26.509</b>	<b>&lt; 0.001</b>
25 - 34 < 35 - 44	<b>6.570</b>	<b>0.01</b>	2.169	0.141	<b>14.214</b>	<b>&lt; 0.001</b>
35 - 44 > 45 - 54	0.997	0.318	0.049	0.825	1.90	0.168
45 - 54 > Over 55	0.571	0.450	0.437	0.508	0.010	0.919
35 - 44 > Over 55	<b>5.487</b>	<b>0.019</b>	0.770	0.380	<b>4.815</b>	<b>0.028</b>

Note: statistically significant results are bolded

Conversely, 35-45 year old’s (50 respondents), reported to give the most feedback across all channels (*app store 34.0%, forums 28.0%, social 26.0%*). Chi-squared tests show there are statistically significant differences between ages (shown in Table 5).

Also of note, respondents under 25 preferred to give feedback to the app store over product forums, shown in bold in table 4. Under 25’s preference for app stores was shown to be statistically significant using a chi-squared test ( $p < .001$ ). Respondents 25 and over used app stores and forums more equally, with those over 44 reporting more forum use. However, the differences in channel use for those 25 and above was not found to be significant.

**Gender:** Men, reported to give more feedback than woman, across all channels, shown in table 6. On apps stores, 20.3% of men and 14.5% of women reported to give feedback. On product forums, 18.0% of men and

**Table 6** User feedback with gender

	Number of Respondents	App Store (%)	Product Forums (%)	Social Media (%)
Men	571	20.32	18.04	8.23
Women	454	14.54	8.15	5.73

**Table 7** User Feedback Type with Gender

Feedback Type	App Store (%)		Forums (%)		Social Media (%)	
	Men	Women	Men	Women	Men	Women
Praise	41.38	50.00	20.39	10.81	38.30	30.77
Report bug	40.52	48.48	73.79	56.76	46.81	42.31
Request feature	26.72	18.18	32.04	21.62	27.66	38.46
Ask question	2.59	6.06	88.35	94.59	68.09	65.38
Recommend to others	12.96	16.67	NA		36.17	19.23
Dissuade others	10.34	6.06	NA		8.51	11.54
Discuss shortcomings	47.41	36.36	NA		46.81	34.62
Dispraise or criticise	18.10	15.15	16.50	8.11	NA	
Helpful situation	36.21	27.27	NA		NA	
Discuss feature	21.55	22.73	NA		NA	
Assist others	NA		55.34	21.62	NA	

8.1% of women reported to give feedback. On social media, the difference was the smallest, with 8.2% and 5.7% respectively reporting to give feedback. Chi-squared tests showed that the difference between men and women respondents was statistically significant for app stores ( $p=0.02$ ) and product forums ( $p<0.001$ ).

Men and women respondents reported some differences in the types of feedback they give on all three feedback channels, shown in Table 7. On app stores, more women feedback givers reported praising apps, than feedback giving men ( $w: 50\%$ ,  $41.38\%$ ) and also reported giving bug reports. More men reported describing a situation an app was helpful, reported an app short coming and request a new features.

On product forums, both men and women were very likely to ask a question about software, with 88.35% of men feedback givers and 94.59% of women. Men feedback givers were more likely to give other types of feedback, including: report a problem, request a feature, give praise, give criticism and assist others. On social media, more men reported recommending software to others and discussing short comings. More women reported requesting new features.

**Employment:** Respondents working full time reported using product forums at a higher rate than those working part time and students (Table 8). However, there is a strong association between employment level and age as 78.57% of students are also under 25. In the bottom half of table 8, all under 25 year old respondents were removed from the analysis, showing the difference between employment levels is not as large when considering only older respondents. The feedback differences between employment groups were not found to be statistically significant, using chi-squared tests, after the exclusion of the under 25 year old respondents.

**Software professionals:** Respondents who work, or have worked in software (software professionals), reported to have given feedback at a higher rate than those who have not worked in software, on all channels (Table 9). Chi-squared tests showed that the feedback rate difference between software professionals and other respondents was significant on all channels (app stores:  $p=0.001$ , product forums:  $p=0.01$ , social media:  $p=0.002$ ).

**Ethnicity:** The majority of survey respondents were either Caucasian (790) or Asian (149), which limited our findings with respect to ethnicity. However, the ethnic demographics of the respondents are representative for a study based in New Zealand and Germany. Only the difference between Caucasian and Asian feedback rate could be investigated and this difference was not statistically significant on any channel.

**Table 8** User Feedback with Employment Type

	Number of Respondents	Forums (%)	Under 25 years (%)
Full-time	215	21.40	20.93
Part-time	78	12.82	66.67
Student	644	10.87	78.57
Full-time (no under 25's)	170	22.94	0.00
Part-time (no under 25's)	26	11.54	0.00
Students (no under 25's)	138	18.84	0.00

**Table 9** Feedback of Software Professionals

	Number of Respondents	App Store (%)	Forums (%)	Social Media (%)
Software Professionals	171	27.49	19.88	12.87
Other Respondents	869	16.32	12.18	5.98

**Table 10** Motivations to Give Feedback

App Store	(%)	Product Forum	(%)	Social Media	(%)
1. Show appreciation	65.15	1. Get help	70.37	1. Show appreciation	56.76
2. Influence improvement	52.02	2. Influence improvement	44.29	2. Influence improvement	51.35
3. Show dissatisfaction	34.85	3. Show appreciation	26.43	3. Show dissatisfaction	37.84
4. Recommend to others	29.80	4. Recommend to others	17.86	4. Connect or socialise	35.14
5. Discourage others	12.63	5. Show dissatisfaction	16.43	5. Recommend to others	32.43
6. Get help	9.20	6. Connect or socialise	15.72	6. Get help	22.73
7. No specific motivation	5.05	7. No specific motivation	7.86	7. Discourage others	14.86
8. Connect or socialise	1.52	8. Discourage others	3.57	8. No specific motivation	8.11

**Answer to RQ1:** There are statistically significant differences in the amount of written feedback given by software users with respect to traditional demographics. For gender, men reported giving more feedback than women, on all three feedback channels. The types of feedback men and women reported to give also varied in notable ways. With age, distinct patterns emerged with respondents between 35 and 45 reporting to give the most feedback and under 18's reporting to give the least, on all channels. Additionally, software professionals reported giving significantly more feedback than other respondents.

## 4.2 Motivations

**RQ2:** *What motivates software users to give online feedback and are there differences across demographics?*

The section presents our findings with respect to what motivates users to give online feedback. The difference in motivations across the three channels and between groups are given.

**Overall:** The reported motivations to give feedback on app stores, product forums and social media are given in table 10. The motivations are given as a percentage of all users who give written feedback on each channel. Multiple motivations could be given by each respondent. As can be seen, the motivations vary across feedback channels. Show appreciation for software was the most common cited motivation on app stores (65.15%) and Social media (56.76%). Get help with software was the top motivation to post on product forums (70.37%). Influencing improvement was also a prominent motivation, being the third most cited on all channels.

**Mobile app prompts (Fig 5):** 52.45% of all survey respondents reported having previously given a star rating to an app. Of those who have given a star rating, 65.75% only gave the rating when prompted within the app, never directly on the app store. 18.16% of respondents reported having given a written review to an app. Of those who have given a written review, 31.75% only gave a written review when prompted to within the app.

**Gender:** *Some differences in motivations to give feedback were reported between men and women.* The percentage of men and woman feedback givers who cited each motivation are shown in table 11. On app stores men were more motivated to discourage others from using a disliked app. On product forums, more men cited influencing an improvement in the software as a motivation. On social media, more women were motivated to

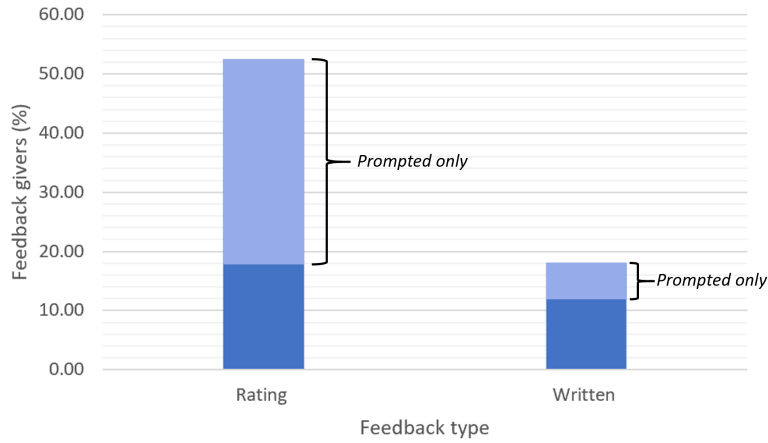


Fig. 5 Impact of in app prompts

Table 11 Motivations to Give Feedback with Gender

Motivation	App Store (%)		Product Forums (%)		Social Media (%)	
	Men	Women	Men	Women	Men	Women
Show appreciation	67.24	72.73	28.16	18.92	57.45	53.85
Show dissatisfaction	36.21	36.36	13.59	21.62	31.91	46.15
Influence improvement	57.76	50.00	49.51	27.03	55.32	42.31
Recommend	29.79	34.62	32.76	30.30	18.45	13.51
Discourage	16.38	6.06	1.94	5.41	10.64	19.23
Connect/socialise	4.31	7.58	13.59	18.92	27.66	42.31
Get help	10.14	5.88	71.11	77.78	41.18	0.00
No specific motivation	0.86	3.03	9.71	0.00	4.26	11.54

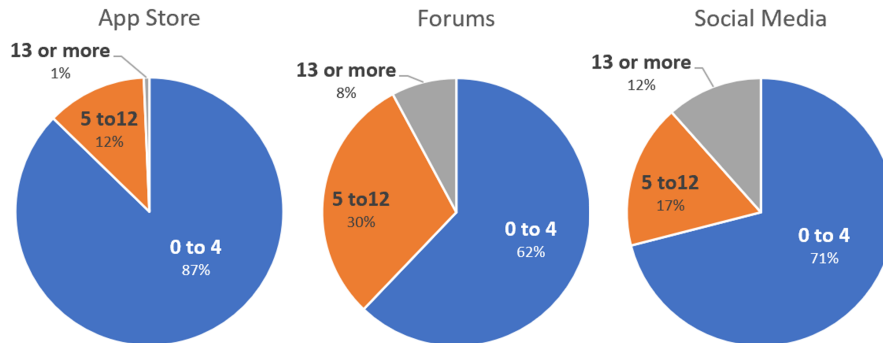


Fig. 6 Feedback given by individual users each year, on each channel

show dissatisfaction and connect or socialise about a software product. Also on social media, more men cited influence improvement and get help. These results are bolded in Table 11

**Feedback frequency:** The majority of feedback givers reported having given feedback between 0 and 4 times in the last year, across all channels (Fig. 6). App stores had the least respondents reporting to give more than 4 pieces of feedback, product forums had the most respondents giving feedback more than 4 times.

**Perception of influencing developers:** Survey respondents who believed that software developers would definitely not be influenced by online feedback, were less likely to give feedback than those who believed influence was more likely, on all channels. However, chi-squared tests showed these differences weren't statistically significant. Feedback rates with perception of influencing developers are shown in table 12

**Other motivations:** Some survey respondents offered additional motivations when they were asked what motivates them to give app store feedback, in an optional open-ended response field. These open responses were categorised into two themes. The most commonly reported other motivation to give app feedback was to *Get rid of the feedback prompt*, with 20 related responses. One respondent said "The number of times they asked

**Table 12** User Feedback with Perception of Influencing Developers

	Number of Respondents	App Store (%)	Forums (%)	Social media (%)
Definitely will	83	14.46	18.07	7.23
Probably will	265	19.25	13.96	7.92
Might or might not	416	18.75	14.90	6.49
Probably will not	248	18.95	9.68	8.06
Definitely will not	27	3.70	7.41	0.00

me to rate it was getting annoyingly high so I just did it so they would stop prompting me", and another said that they were "annoyed by the disturbance: hope that no more ratings will be asked after one rating was given".

The other theme identified was to *Receive in-app rewards*, with seven related responses. For example, one respondent said "you get coins/free stuff if you rate the app sometimes" and another said they were motivated by "In-app benefits from Rating the app."

**Answer to RQ2:** Showing appreciation was the top motivation given to write feedback on app stores and social media. On product forums, getting help was the most commonly cited motivation (table 10). Differences in the motivations of men and women to give written feedback on each channel were also reported.

In-app prompts were reported to be very effective at motivating app users to give star ratings, but less effective at eliciting written feedback. Individual survey respondents reported engaging with each feedback channel at different frequencies, writing on product forums the most times a year and least on app stores.

#### 4.3 Reasons users don't give online feedback

**RQ3:** *When software does not meet expectations, what are the reasons users decide not to give online feedback?*

Respondents were asked to rate their agreement, on a five point Likert Scale, with seven predefined reasons that they didn't give feedback in the past (Table 2), when faced with software issues.

**Overall:** Respondents reported the same top three reasons not to give online feedback for all three study channels, though the order varied across the channels (see Fig 7). The top three reasons were: (1) Users would look for an existing answer online instead of giving feedback. (2) Users would try to find an alternative app instead of giving feedback. (3) Users felt a resolution to their problem would take too long, and therefore wouldn't give feedback. On forums and social media, finding an existing answer had the highest level of agreement from respondents (83%, 79%). On app stores, all three top reasons had an agreement level of 78%.

Respondents most commonly reported not to be aware their feedback could influence software improvements on social media (54%), then on app stores (48%), and least commonly on forums (38%). Forums were most commonly agreed to be confusing or hard to use (28%), then app stores (19%), with social media the least reported to be confusing (13%).

**Gender:** *Differences in the reasons not to give online feedback were reported between men and women on all three channels.* On app stores, more women reported to not be aware they could influence software improvements with feedback and found app stores confusing or hard to use. Women also reported to be more likely to look for an existing answers, and believe a resolution to their issue would take too long. All these results were found to be statistically significant, and have been bolded in table 13.

On forums, men reported more often that they would look for an existing answer instead of giving feedback, however this wasn't statistically significant. On social media, women more often reported not being aware they could influence software improvements. Men more often reported not to give social media feedback because they felt it wouldn't influence other users. Both these social media results were found to be statistically significant and have been bolded in table 13.

**Age:** *Differences in the reasons not to give online feedback were reported between those under 25 and those 25 and over.* More under 25's agreed that app stores are confusing or hard to use. Under 25's also more commonly reported to feel their app store feedback wouldn't be seen or lead to a resolution. Those 25 and over more often agreed that they wouldn't give feedback because they couldn't influence other users. These results were found to be statistically significant, as shown in table 14.

On forums, significantly more under 25's agreed they weren't aware their feedback could influence software improvements. Under 25's also more commonly reported to feel their forum feedback wouldn't be seen or lead to a resolution. On social media, under 25's more commonly agreed that a resolution to their software issues would

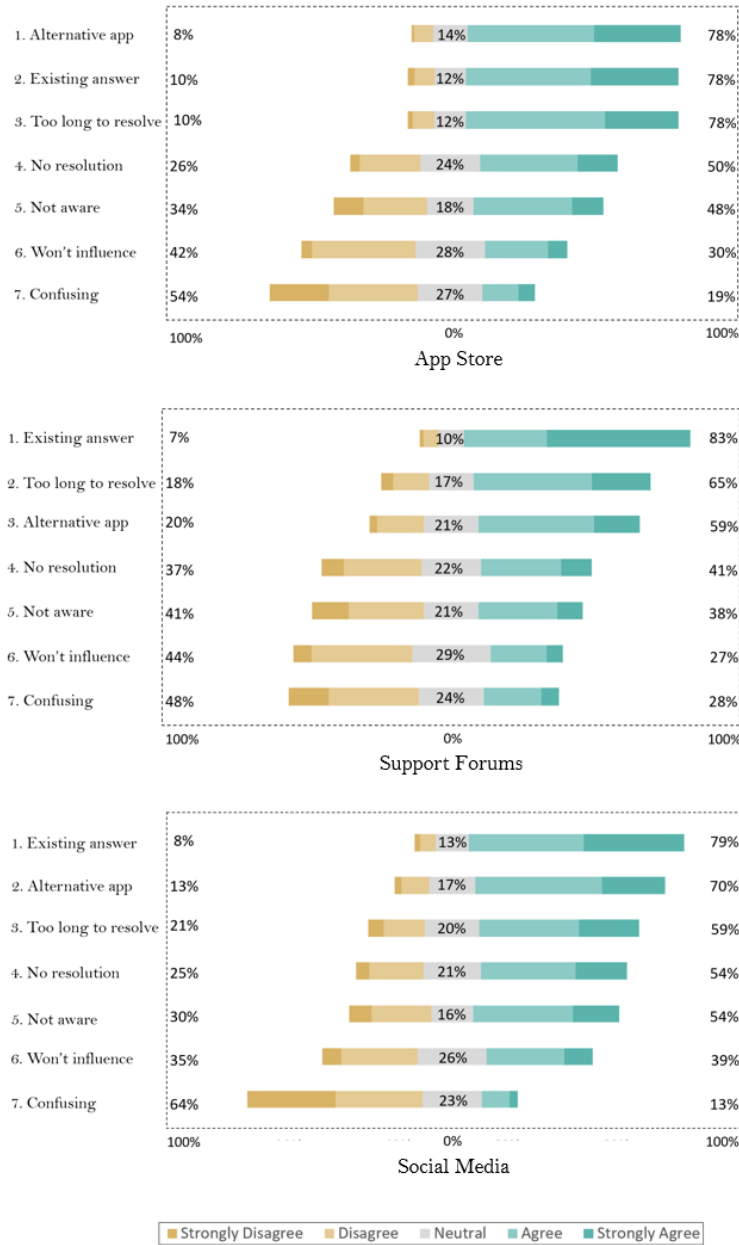


Fig. 7 Reasons not to give online feedback - Likert Scales

Table 13 Reasons not to give feedback, agreement level by gender

	App Store			Product Forums			Social Media		
	Men (%)	Women (%)	Chi2 (p)	Men (%)	Women (%)	Chi2 (p)	Men (%)	Women (%)	Chi2 (p)
Alternative app	76	80	1.65	46	43	0.71	67	73	1.20
Existing answer	<b>74</b>	<b>82</b>	<b>8.49 (**)</b>	67	57	0.07	79	80	0.82
To long	<b>75</b>	<b>81</b>	<b>5.45 (*)</b>	52	45	0.10	55	62	3.17
No resolution	48	53	2.66	30	32	3.64	55	52	0.23
Not aware	<b>41</b>	<b>55</b>	<b>21.32 (***)</b>	28	30	3.56	<b>51</b>	<b>56</b>	<b>4.47 (*)</b>
Won't influence	28	32	0.01	20	19	0.15	<b>43</b>	<b>34</b>	<b>5.44 (*)</b>
Confusing	<b>17</b>	<b>22</b>	<b>7.65 (**)</b>	21	20	0.35	14	12	0.58

Note: statistically significant results are bolded  
 \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$

take to long and therefore wouldn't give feedback (62%, 52%). These results were all found to be statistically significant (Table 14).

**Other reasons:** Some survey respondents offered other reasons they don't give feedback, in an optional open response field. For each feedback channel, these other reasons have been categorised into themes, with themes cited by at least two respondents shown in table 15

**Table 14** Reasons not to give feedback, agreement level by age

	App Store			Product Forums			Social Media		
	25 and over (%)	Under 25 (%)	Chi2 (p)	25 and over (%)	Under 25 (%)	Chi2 (p)	25 and over (%)	Under 25 (%)	Chi2 (p)
Alternative app	79.0	77.7	0.006	60.4	58.6	0.071	70.7	69.2	<0.001
Existing answer	78.0	77.8	0.016	85.5	82.0	<0.001	80.7	78.3	2.096
To long	76.7	78.3	0.002	67.1	63.9	0.115	<b>51.7</b>	<b>61.8</b>	<b>8.634 (**)</b>
No resolution	<b>46.3</b>	<b>52.4</b>	<b>7.071 (**)</b>	<b>36.9</b>	<b>43.0</b>	<b>5.335 (*)</b>	49.3	55.5	1.888
Not aware	41.3	50.5	2.615	<b>28.2</b>	<b>43.9</b>	<b>19.656 (***)</b>	50.7	55.0	0.949
Won't influence	<b>34.7</b>	<b>28.0</b>	<b>5.489 (*)</b>	26.7	26.5	0.038	33.0	41.5	0.923
Confusing	<b>13.7</b>	<b>21.9</b>	<b>8.728 (**)</b>	28.6	26.9	0.001	15.3	12.3	2.511

Note: statistically significant results are bolded

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

**Table 15** Other reasons to not give online feedback

Channel	Summary	Example	Number of Respondents
App store	Too much effort required	"It would take too long to write a review!"	51
"	Want to stay anonymous	"I try to stay anonymous."	7
"	Too many reviews already	"The fact that there are so many reviews online on the app store was a reason that I thought it would change nothing to write another review"	3
"	Avoid having bad influence	"Don't want to have a bad influence due to my bad review"	2
"	In-app feedback	"When the review request showed up, I thought I could direct write a review. But when I clicked the button, I had to use the App store to write the review".	2
Forums	Don't want to create account	"I don't want to make an account"	10
"	Too much effort	"Can't be bothered"	5
"	Want to stay anonymous	"I'm aware that anything I post online could be used against me, even in the distant future."	4
"	May look bad	"Look bad if already asked"	2
"	Faster channel instead	"Id rather use any other support method such as email or chat or phone because I feel they respond faster to that"	2
Social media	Don't use social media	"I dont use social media"	25
"	Wont post software issues	"I don't want to share my support request in social media"	13
"	Want to stay anonymous	"I want to stay anonymous"	9
"	Don't post on social media	"I generally don't post on social media."	6
"	Too much effort	"I was too lazy"	3

On app stores, the most common other reason given not to provide feedback was, *Too much effort required*, with 51 related responses. Two typical responses were, *"It would take too long to write a review"* and *"It seems like to much of a hassle"*. *Wanting to stay anonymous*, was the second most cited other reason on the app store, with seven related responses.

On forums, the most common other reason not to give feedback (ten responses) was that the respondents *Don't want to create an account*. One respondent said *"In most cases you have to create an account for the forum which makes it more difficult and time consuming to generate a post"*. *Wanting to stay anonymous* was also a barrier to feedback on forums, with five related responses.

On social media, the most common other reason not to give feedback was that respondents *Don't use social media* (25 responses). Twelve respondents said they *Won't post software issues* on social media, one saying *"I don't want that my close friends and colleagues see such posts of mine."*. *Wanting to stay anonymous* when reporting software issues on social media was given by nine respondents.

**Table 16** Methods to encourage feedback, agreement level by gender

	Men	Women	<i>Chi2</i>	<i>p</i>
Financial incentive	82.6	82.8	0.001	0.981
In-app rewards	65.6	65.6	0.468	0.494
Smart assistant	<b>22.8</b>	<b>28.7</b>	<b>6.01</b>	<b>0.014</b>
Audio feedback	18.4	15.6	0.840	0.359
Video feedback	11.4	11.0	0.018	0.893

Note: statistically significant results are bolded

**Table 17** Other new methods to encourage online feedback, all channels

Summary	Example	Number of Respondents
Want a quick response	"I could get a response to my review immediately"	18
Give anonymous feedback	"The feedback would be completely anonymous."	7
Clear track record	"Show a track-record of implemented stuff from reviews"	5
Feedback to a human	"I could give feedback in a conversation with a human"	4
In-app feedback	"I could give feedback within the app"	3
Easier to post	"If posting was easier"	3

**Answer to RQ3:** Looking for an existing answer, finding an alternative app and feeling a resolution would take too long were the top three reasons not to give feedback, across all three study channels (see Fig. 7). Between channels, most respondents reported not being aware they could influence software improvements on social media, and Forums were most commonly reported to be hard or confusing to use. Significant differences in the reasons not to give feedback were also reported between men and women (Table 13), and between age groups (Table 14). Common other reasons not to give feedback were also reported by multiple respondents in open-ended responses, including: Wanting to stay anonymous, not wanting to create an account (on forums) and not wanting to post software issues on social media.

#### 4.4 Methods to encourage online feedback

**RQ4:** *What new methods are perceived to increase the likelihood of software users giving online written feedback?*

Respondents were asked to rate their agreement, on a five point Likert Scale, with five predefined potential new methods to encourage their feedback (Table 2).

**Overall:** A small financial incentive was the most agreed method to increase respondents probability of giving online software feedback (82%) (Fig. 8). Next, in-app rewards were thought to be potentially effective, with 65% agreement.

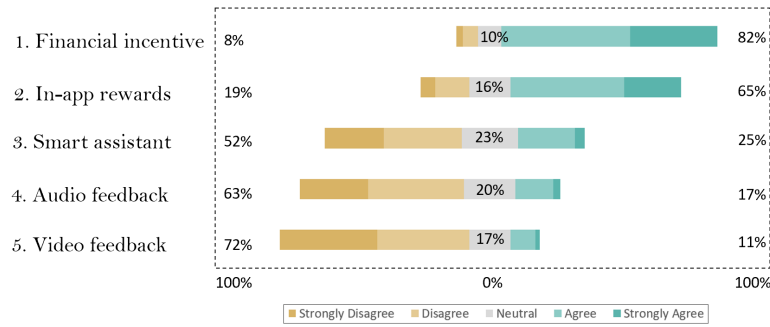
Three alternative methods for giving online feedback weren't seen as being as effective at encouraging feedback. Feedback through a smart assistant was most favoured of these (25%), then the option to give feedback via audio recording (17%) and least agreement was given to feedback via video recording (11%).

**Gender, Age and Employment:** More women than men agreed that the ability to give feedback through a smart assistant would increase their probably of giving feedback, which was found to be statistically significant (Table 16). The agreement level for the four other proposed methods were very similar between men and women, and weren't statistically significant. With age and employment, the perceived effectiveness of the potential incentives were also similar between groups, with the differences not found to be statistically significant.

**Other methods:** Some survey respondents offered other methods to encourage their feedback, in an optional open response field. These *other* encouragement methods have been categorised into themes, themes with at least two responses are shown in table 17. The most common suggested encouragement method (18 responses) was that users *Want a quick response* to show that the feedback had been seen by developers. One respondent said they would be encouraged if "I get better feedback like they saw my feedback and are trying to solve my problem", another respondent said "I would do it, if I know for sure that I will get an answer".

Being able to *Give anonymous feedback* was said to be encouraging by seven respondents. And, five respondents said that seeing a *Clear track record* of developers addressing feedback would increase their likelihood of giving feedback. One respondent said they would be encouraged if "I saw others making a difference with their suggestions", another respondent said "If there were lists linked on the store/forum/social media which showed on which improvements the developers are working".





**Fig. 8** Methods to encourage online feedback - Likert Scale

**Table 18** User Feedback with Device Type

Device	Number of Respondents	App Store (%)	Product Forum (%)	Social Media (%)
Android	618	21.84	13.75	6.80
iPhone	423	13.48	12.77	7.33
Linux	94	31.91	26.60	10.64
Windows	759	19.10	14.6	6.46
Mac	275	16.73	12.36	10.18

**Answer to RQ4:** Financial and in-app rewards were seen by respondents as better methods to encourage feedback, compared to new options such as giving feedback through a smart assistant (Fig. 8). Women, compared to men, more commonly felt an option to give feedback through a smart assistant would be encouraging (Table 16).

Additional methods to encourage feedback were suggested by respondents in open-ended responses. The most common suggestions were: Wanting a quick responses to show that feedback had been seen; The ability to give anonymous feedback; And, showing a clear track record of user feedback being addressed.

#### 4.5 Type of software and duration of use

**RQ5:** Does the likelihood of giving online written feedback vary based on the type of software used and the duration of software usage?

With respect to computer and phone type, survey respondents were asked to select all device types they use. Therefore, respondents could be counted in multiple categories (e.g. Android and iPhone). For phone, 1.44% (15) of respondents reported using both Android and iPhone. For computer, 10.38% (108) of respondents reported using more than one computer type, with dual use of Windows and Linux being most common combination (4.90%).

**iPhone/Android:** Android users reported giving feedback to the app store at a higher rate than iPhone users (Table 18). 13.48% of iPhone users reported having given written feedback on app stores compared to 21.84% of Android users. A chi-squared test showed this difference to be statistically significant, given in table 19.

**Windows/Mac/Linux:** Linux users reported giving written feedback on app stores and product forums at a higher rate than Windows and Mac users (Table 18). Chi-squared tests showed these differences to both be statistically significant (Table 19). The difference between Windows and Mac users feedback was not statistically significant.

**Hours of computer use:** Respondents who reported a higher daily computer use (hours), were more likely to give feedback to product forums. The least forum feedback was given by respondents using their computer less than 1 hour or between 1 and 4 hours a day. Those using their computer between 4 and 8 hours gave more feedback and those using their computer more than 8 hours a day gave at the highest rate. Chi-squared tests showed that the feedback rate differences between 1 - 4 hours and 4 - 8 hours and between 1- 4 hours and over 8 hours were statistically significant (Table 21).

**Hours of phone use:** Respondents who reported a higher daily phone use (hours), were more likely to give feedback to social media. However, chi-squared tests showed these differences weren't statistically significant.

**Table 19** User Feedback with Device Type, Significance Tests

	App Store		Product Forums	
	<i>Chi2</i>	<i>p</i>	<i>Chi2</i>	<i>p</i>
Android > iPhone	<b>11.144</b>	<b>0.001</b>	0.087	0.769
Linux > Windows	<b>7.651</b>	<b>0.006</b>	<b>8.073</b>	<b>0.004</b>
Linux > Mac	<b>8.974</b>	<b>0.003</b>	<b>9.531</b>	<b>0.002</b>

*Statistically significant results are bolded*

**Table 20** User Feedback with daily computer use

Daily Computer Use	Number of Respondents	App Store (%)	Forums (%)	Social Media (%)
Less than 1 hour	109	18.35	10.09	6.42
1 - 4 hours	436	15.14	9.40	5.96
4 - 8 hours	363	20.66	17.08	7.99
More than 8 hours	110	21.82	23.64	9.09

**Table 21** Computer Daily Use, Significance Tests (Product Forums)

Daily Computer Use	<i>Chi2</i>	<i>p</i>
<i>Less than 1 hour &lt; 1-4 hours</i>	0.001	0.971
<i>Less than 1 hour &lt; 4-8 hours</i>	2.619	0.106
<i>1 - 4 &lt; Over 8 hours</i>	<b>15.233</b>	<b>&lt; 0.001</b>
<i>Less than 1 &lt; Over 8 hours</i>	<b>6.221</b>	<b>0.013</b>
<i>1-4 hours &lt; 4-8 hours</i>	<b>9.722</b>	<b>0.002</b>
<i>4-8 hours &lt; Over 8 hours</i>	1.983	0.159

*Statistically significant results are bolded*

**Answer to RQ5:** Statistically significant differences were reported in the amount of written feedback given based on the type of software used and the duration of daily use. Respondents who spend more hours each day on their computer reported giving more written feedback to product forums. Those using the Linux OS gave more written feedback to app stores and product forums than those using Windows and Mac. Android users reported giving more written feedback to app stores than iPhone users.

## 5 Discussion

In this section, we first discuss the threats to validity of our study and then describe the implications and potential avenues for future work.

### 5.1 Threats to validity

Convenience sampling, used in both surveys to elicit survey participants, is a non-probabilistic sampling method and a possible source of bias [28]. The target population of the study's are users of software and mobile applications. In the first survey, participants were engaged via Facebook, Twitter, the Karlsruhe Institute of Technology survey pool and in Auckland cities public areas. In the second survey, participant were engaged through the Karlsruhe Institute of Technology survey pool, Zhejiang University's online student forums and with a follow up email to first survey participants. Therefore, in both surveys only a subset of the target population had the opportunity to participate. Additionally, all respondents who completed the survey were self-selected, and their feedback habits may not generalise to all software users.

To mitigate this bias, we collected data from a large number of software users, 1040 participants in survey one, and 936 participants in survey two. Recruitment was done through multiple channels to increase the odds of recruiting a diverse set of respondents. However, we cannot claim that our results generalise outside of our sample. Future studies can replicate the survey's (available on Zenodo) to validate our findings.

Our participants are not representative across all demographics. The demographics of our respondents are listed in Table 3. The majority of participants in survey one are white/European and many are students. In

**Table 22** User Feedback with Daily Phone Use

Daily Phone Use	Number of Respondents	App Store (%)	Forums (%)	Social Media (%)
Less than 1 hour	52	15.38	15.38	3.85
1 - 4 hours	664	16.57	13.70	6.63
4 - 8 hours	266	22.93	11.65	7.89
More than 8 hours	51	17.65	17.65	13.73

survey two, participants were primarily of Asian (of Chinese nationality) and white/European descent, also with many students. When presenting our results, we present proportions based on the total number of respondents in each demographic group. We also used chi-squared tests to determine significance between different demographic groups, which accounts for the sample size of each population being compared. Therefore, findings found to be statistically significant had a sufficient number of respondents in each demographic to satisfy the test. However, due to a low number of participants in some demographic groups, not all demographics could be analysed. Future studies should replicate this survey to enable analysis of additional demographics.

In addition, the majority of participants identified as men or women. We did give participants the option to self-specify gender, but very few participants chose to self-specify. Thus, our analysis was limited to only the differences between participants who identified as men and women. Again, future work should replicate the study to enable analysis beyond these binary genders.

Our results are based only on self-reported feedback habits. Demographic information of feedback givers is not readily available on the feedback channels we investigated (often the real name of the writer isn't even given). This data sparsity problem means our findings can't be directly validated against actual feedback data. One previous study, by Guzman et al. [8], approximated the gender of feedback givers on app stores from their usernames. Using these approximations, they found that men were more likely than women to provide feedback on the Apple app store, which is in line with what our respondents reported and supports our findings.

## 5.2 Implications and Future Work

**Implication 1:** *The findings presented in this paper suggest that, when leveraging online user feedback, to get the most representative user views and desires, feedback from multiple feedback channels should be considered.* We found statistically significant differences in the users who reported to give feedback on app stores, product forums, and social media with respect to traditional demographics and software usage habits. For example, older respondents prefer product forums to app stores, while younger respondents prefer app stores.

Importantly, a majority of feedback giving respondents reported only engaging with one of these three feedback channels. This indicates that considering multiple channels will enable feedback from a more diverse set of users.

We also found key differences in what motivates software users to engage with each of the three channels. The most cited motivation on app stores and social media was to show appreciation for the app/software. Whereas, on product forums showing appreciation was much less of a motivating factor, instead, getting help was the top cited motivation. Showing dissatisfaction, recommending and discouraging others were also significantly more cited on app stores and social media. On social media, connecting with other users was reported to be a more common motivation than on the other channels.

These motivation differences suggest that the feedback on each online channel is likely to contain different product development insights. For example, feedback on product forums contain users trying to get help and therefore likely describes ways the software is unintuitive or difficult to use. On app stores and social media, users are more motivated to communicate how they feel about the software/app to the developers and other users. These differences again emphasize the benefit to considering feedback from all channels, as each channel may provide unique insights.

**Implication 2:** *Our findings suggest possible approaches to encourage feedback from underrepresented groups and new directions for investigation.* We saw some demographics were less likely to give feedback than others. For example, respondents 35-44 years old report to provide the most feedback on all three feedback channels, while both older and younger respondents gave less feedback (Fig 4). Also, men reported giving feedback at a higher rate than women across all three channels. This is in line with the results of Guzman et al. which found that the Apple app store had more feedback from men [8].

Several reasons not to give feedback were more often cited by underrepresented groups. Women more frequently (than men) reported that they found app stores confusing or hard to use, felt a resolution would take too long, and to not be aware feedback could influence software improvements (Table 13). More under 25's, than

older respondents, found app stores confusing or hard to use, reported to not be aware feedback could influence improvements, and felt a resolution to feedback would take too long (Table 14).

Therefore, in-order to encourage feedback from underrepresented groups, we propose the above reasons not to give feedback should be addressed. Online feedback channels should make their interfaces easy to use, for these groups, and add clear messaging about the potential to improve the software. Methods proposed by our respondents may help address these issues. For example, giving a quick response to feedback could be used to emphasise the connection to software improvement and help address the perception that a resolution will take too long. Clearly showing a track record of addressing feedback would also promote awareness of the process and help motivate user input.

Recent research found that most software has gender inclusivity issues [33], so it is possible that similar inclusivity issues exist in the software that collects online feedback. Future work could investigate feedback interfaces that underrepresented groups find encouraging and easy to use. Lab trials could be carried out to evaluate if the approaches identified above encourage feedback in a practical context. The option to give feedback through a smart assistant, which was more commonly endorsed by women (than men) (Table 16), could be included in the evaluation. Additionally, new chat bot approaches such as a conversational agent (Ladderbot) [34] would be well suited to evaluation in a lab based experiment.

Of course, increasing online user feedback is not the only way to ensure the voice of all users is being heard in the requirements elicitation process. Software teams could also consider other elicitation techniques and should ensure diversity in the users. Interviews or focus groups could target underrepresented groups, or modern solutions could be applied to extend requirements elicitation to a larger number of users, with a focus on including a diverse sample. For example, conversational agents show promise for eliciting requirements at scale [34]. In addition to ensuring other elicitation techniques are considering diversity of users, use of personas could also help [35], [36]. By creating a range of personas that would cover the diversity of the potential end users and linking requirements to these underlying personas, potential inclusion related issues could be uncovered in the requirements.

**Implication 3:** *Feedback prompts are effective at eliciting feedback for app stores and may be effective if applied more widely in computer software. However, many respondents reported being annoyed by prompts and rushing to close them. This is likely a factor in prompts not being as effective at eliciting detailed feedback.* Mobile apps widely use prompts to elicit feedback. More survey respondents reported giving written feedback on app stores than on any other channel. Much of this feedback is prompted. The number of respondents who have provided unprompted app store feedback (12.39%) is very similar to the number who report to have written posts on product forums (13.45%). This suggests that the prompts are successful in eliciting additional feedback givers. The prompts are even more effective at eliciting app ratings, which take less time to provide than written feedback.

However, many respondents reported being annoyed by prompts, in their open-ended responses. One respondent said "The number of times they asked me to rate it was getting annoyingly high so I just did it so they would stop prompting me". This may partly explain why prompts are not as effective at eliciting written feedback, users want to get rid of them and often just give a fast rating. There may also be a danger that prompts negatively effect user experience.

Future research could investigate if prompt timing and frequency effect the likelihood of eliciting written feedback and their effect on user experience. Other prompt types, such as multi-choice questions could be trialled in-place of open-response fields, to elicit detailed feedback. Additionally, ways to integrated prompts into other feedback channels can be investigated.

**Implication 4:** *The types of software devices respondents use also has an association to feedback habits. Investigating why users of some devices give more feedback may give insights into how to motivate and facilitate feedback.*

On phones, more Android users give written feedback than iPhone users. It is not clear why there are differences in feedback across devices, but it may be influenced by differences in prompt rates, app quality, app store usability or even those who choose to use each phone type. iOS developers could benefit in understanding these factors in order to encourage more feedback from their users.

On computers, respondents who use the Linux OS more commonly had given written feedback to app stores and product forums than those who do not use Linux. The feedback habits of Mac and Windows users were relatively similar across all feedback channels. The higher feedback rates of Linux users may be related to the prevalence of software developers using it. In fact, 43% of respondents using Linux also reported working in the software industry, compared to only 16% of all respondents. Our results showed that software professionals are more likely to provide online feedback, possibly because they understand how that feedback will be used by development teams. Future research can investigate more thoroughly the reasons for differences across devices.

**Implication 5:** *Our findings suggest approaches to motivate user feedback, which can be employed when more feedback is needed, such as for new applications or those with small user-bases.* User feedback serves two primary functions, it is used as a source of requirements by developers, and potential users consider reviews when

choosing applications [1]. New applications and those with small users bases can be limited by a lack of user feedback. Previous research has even highlighted the issue of small applications paying for "fake" reviews [37].

This study suggests approaches developers can use to elicit additional feedback. A small financial incentive was the most commonly endorsed method to encourage user feedback (82%) (Fig. 7). In-app rewards were the second most popular potential encouragement method (65%), and maybe a more realistic option for apps with limited resources. Previous research found that in-app rewards such as digital goods, game progression, and customisation options can motivate user behaviour [19]. The ability to give anonymous feedback could also encourage additional user engagement, as it was suggested by multiple survey respondents independently. However, the benefits of anonymous feedback must be weighed against the possibility of encouraging more fake reviews and reduced user accountability for the quality of their feedback [37]. Future work could look at ways to satisfy (some) users desire for anonymity while still maintaining user accountability. One approach could be to allow feedback through existing accounts, such as Google or Facebook, and not accessing or sharing account details while the terms of services are adhered to.

Our findings also suggest that providing quick responses to feedback givers can encourage feedback, as well as showing a clear track record of addressing previous reviews. Future work could study these approaches effectiveness when they are used by developers in practice.

**Other avenues for future work:** *Investigate other feedback channels.* Our study was limited to app stores, product forums, and social media. Future work could perform a similar investigation considering other feedback channels like issue trackers.

*Replicate survey in other countries.* Our survey respondents were mostly from three countries; New Zealand, Germany and China. Future work could replicate our study by eliciting responses in additional countries. This would also enable analysis at the ethnicity level if more ethnic diversity in the participants was achieved.

*Understand gender differences in product forum engagement.* In addition to men being more likely than women to post on product forums, men also reported using products forums for different reasons. While men and women both primarily used forums to ask software related questions, men also reported higher rates of giving other types of feedback on product forums, including: reporting problems, requesting features, praising and criticising the software, as well as assisting others. Further research is needed to understand the gender difference in engagement with product forums.

*Making missing demographics more transparent.* Currently, it is difficult for product development teams to know whether the feedback collected from online feedback channels is biased and misses the voices of some underrepresented groups. Future research could devise ways to make this more transparent to enable software development teams to more proactively consider the needs of the underrepresented groups and produce more inclusive software.

*Investigate differences in feedback rates for different types of software applications.* Software users may be more likely to give feedback on some types of software compared to others. Feedback on different software types may also vary between user demographics. Understanding these differences would give valuable context to the requirements sourced from the feedback.

## 6 Conclusion

The online user feedback written on app stores, product forums, and social media is a valuable source of requirements for software developers and has been a focus of requirements engineering researchers. However, limited studies have been done to understand which software users give this feedback, what motivates them to give feedback and dissuades them when they don't. In this work, we first directly surveyed 1040 software users about their feedback habits, software use, and demographic information. The initial work was then extended, by surveying 936 users on reasons they don't give feedback when they have software issues and ways they could be encouraged to.

The responses indicate significant differences in the demographics of software users who give feedback on each online channel. For gender, men reported giving more feedback than women, and with age respondents between 35 and 45 reported to give the most feedback across all channels. We also found strong evidence that younger software users (under 25), prefer to engage with app stores whereas older software users use product forums at equal (to app stores) and sometimes higher rates.

We identified key differences in what motivates software users to engage with each of the three channels. Comparing channels, respondents reported the top motivation to give feedback on app stores and social media was to show appreciation, whereas on forums the most cited motivation was to get help with software products. Differences between the motivations of men and women to give feedback were also reported for each of the channels. Respondents reported in-app prompts to be significantly more effective in motivating them to give app ratings over written feedback. Additionally, individual feedback givers reported to engage more times a year on product forums than on app stores.

The top three reasons not to give feedback, as reported by respondents, were consistent across the three study channels, if not in the same order, namely: 1) Looking for an existing answer instead, 2) finding an alternative app instead, and 3) feeling a resolution would take too long. Significant differences in the reasons not to give feedback were also identified between men and women, and between different age groups. Multiple respondents also reported common additional factors that dissuade them, including wanting to stay anonymous, not wanting to create an account on forums, and not wanting to share software issues on social media.

Financial and in-app rewards were seen by respondents as better methods to encourage feedback, compared to new options such as giving feedback through a smart assistant. Additional methods to encourage feedback were suggested by respondents in open-ended responses, including: Wanting a quick responses to show that feedback had been seen; The ability to give anonymous feedback; And, showing a clear track record of user feedback being addressed.

Differences in feedback habits were also reported with the ways respondents use software. Those who spend more hours each day on their phone or computer reported giving more feedback about the software they're using. The software platform being used also presented a relationship to feedback rates, with more Linux (computer) and Android (phone) users reporting to give feedback than those who use the alternatives.

The findings presented in this paper give meaningful insights into which software users give online feedback and the motivations they have to give it. We found notable differences in those who give feedback to each online channel, which emphasises the need to mine all three feedback channels to get the most representative requirements from software users when leveraging online feedback. Reasons software users don't give feedback and methods to encourage them have also been identified. These may give insights into how to improve feedback rates (when they are low), especially from underrepresented demographic groups.

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