What Do Developers Reply To? An Empirical Study of the Top Unmanned Aerial Vehicles (UAVs) Apps

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Abstract—**Most modern UAVs/drones have a dependency on using a mobile device as part of the flight systems. The drone manufacturers launch the controlling app for the drones in mobile app stores. There has been a tremendous upsurge in the number of UAVs (Unmanned Aerial Vehicle) mobile apps on the Google Play Store over the past few years. A UAV/Drone app user expresses the experience with the app by providing comments on the Google Play Store. Whereas, the developers interact with the user by posting replies to users' comments. Feedback in users' comments enables developers of mobile apps to discover issues, such as features requests, bugs to fix, and app maintenance requests, in a timely manner. The value of responding to a user review of drone apps has never been explored. We conducted the largest and most extensive empirical study of UAV mobile apps to-date by analyzing the 1,825 UAV mobile apps across twenty-five categories, with 162,250 reviews (user comments and developers' replies). We categorized the developer replies into seven major categories. We also find that 35% of the developer's replies are associated with providing direct solutions to the drone app user's problems. Whereas, only 1% of the developer replies are related to the app's monetary refund issues.**

Keywords-component; Developer reply, Mobile App, Google Play Store, Drones, UAV

I. INTRODUCTION

Google Play, referred to as the Android Market, is Google's official store and portal for Android apps, games and other media content for the Android OS phone, tablet or Android TV device. Purchases made on the Google Play store can not only be shared and synced across mobile devices but can also be downloaded and stored on the Google cloud. As of 2017, Google Play features over 3.5 million Android applications, with 2.8 million apps available for download presently.

Within the past five years, i.e., recently, there has been a tremendous increase in the number of Unmanned Aerial Vehicles (UAVs) (also known as a drone; a term used interchangeably with UAV in the paper) apps on the google play store. The UAV is an aircraft without a human pilot on board. UAVs can be navigated via control from the ground through software-controlled flight plans in their embedded systems, functioning along with onboard sensors and GPS. Small UAVs mostly use lithium-polymer batteries, while larger vehicles rely on conventional airplane engines. Some of these drones are equipped with cameras that allow the user to record videos or capture pictures. These drones are controlled by certified operators. Also, there exist many drone hobbyists.

A. Importance of Developer Reply

After interaction with drone apps, users can instantly express their experience with an app and can directly communicate with developers via app reviews; a direct channel between users and developers. Feedback in users' comments enables developers of mobile apps to discover issues, such as features requests, bugs to fix, and app maintenance requests, in a timely manner [6][18]. Perceiving the importance of mobile apps user feedback and developers interaction with the uses via comments, Google Google Play Store, and Apple App store have established a review response system that:

(a). Allows the developers to respond to an app user review quickly. The developer in the response can address the user concern, provide details of the app functionalities, acknowledge users' feature requests, or simply thank the user for their feedback and

(b). Quickly notify the user who posted the review, the developer's reply/feedback, and provide an option to update the corresponding app review [2][7].

It has been established via empirical studies [9][15][16] that developers provide feedback/response to mobile app users in a timely and accurate manner to:

(a). Improves user experience and

(b). Increases the app popularity and rating

B. Problem Statement

The pace of innovation in the drone industry is increasing at a tremendous rate. Thousands of companies compete globally, with more emerging every day. Besides the explosion in production, prices have reduced exponentially. Additionally, drones are being incorporated with an array of sensors, cameras, and software applications. Yet, there exists no study to-date highlighting user issues related to drone apps that can assist app store stakeholders, especially in producing quality drone apps. As well, examine the developer replies to these complaints to better understand (a) the areas/user concerns that receive enough attention and (b) the areas/user concerns that are important to users but not well attended by the developers. There have been a few studies in the literature aiming at software review-related research, they all neglect the developer's replies in their analysis.
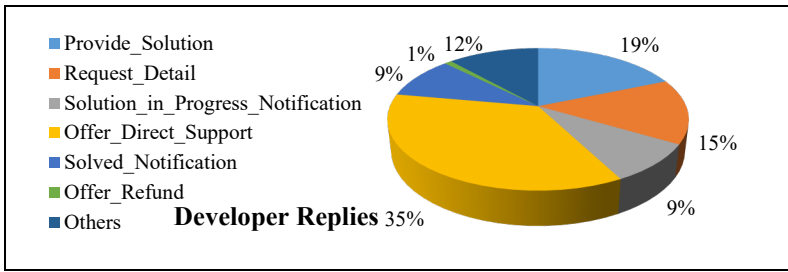
Figure 1. Percentage of developer replies based on the perceived categories
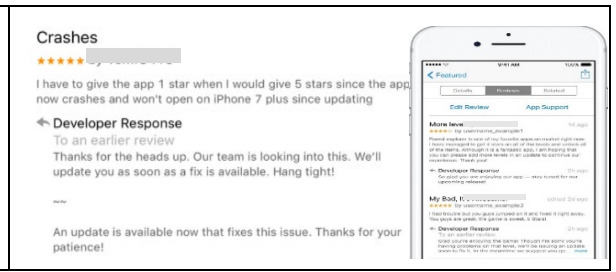

Figure 2. A sample developer response to a UAV mobile app user.

Thus, the paper (a) analyzes the developer's responses (as comments) to drone app users, (b) categorizes the developer's answers into types based on the user issues being handled, and (c) systematically examines and provides details of the category.

II. RELATED WORK

Previous works on reviews of mobile apps affirm that user reviews play a vital role in the triumph of an app. Kim et al. [12] found that reviews of an app influenced its purchase the most. Ha and Wager [8] found that users who are evaluating the apps are doing so only when they are either extremely satisfied or dissatisfied. Fu et al. [5] have performed Topic Modelling on 1 and 2-star ratings to discover the most common types of complaints in each category of apps. Khalid et al. [11] studied app store 1 and 2-star reviews to identify what iOS app users frequently complain about. Khalid et al. [11] studied low-rated reviews of 20 free iOS apps and found that Functional Error, Feature Request, and App Crash were the categories that were often complained about. In contrast, privacy and ethics, feature removal and hidden costs complaints were the most impactful ones. Martin et al. [14] provided a survey paper that contains a more exhaustive list of studies conducted on iOS Apps. Hassan et al. [9] studied 4.5 million reviews with 126,686 developer responses of 2,328 top free apps from the Google Play Store. The study was an attempt to (i) explore more about the dynamic nature of the review-response mechanism and (ii) find if responding to a review often has a positive effect on the rating that is given by the user. Noei et al. [17] studied 435,628 reviews from 49 apps (across 10 categories) from the Google Play Store, performing topic modeling to identify the categories of user feedback. In contrast, Mahmoudi et al. [13] studied only the review of 19 Android wearable apps and concluded that Functional Errors and Cost categories receive the most complaints. In contrast, Installation Errors, Device Compatibility, and Privacy & Ethical Issues are the ones causing a higher negative impact on app ratings. Hu et al. [10] investigated 68 hybrid apps from the Google Play Store and iOS app store to determine whether they achieve consistent star ratings and user reviews across app platforms.

III. DATA COLLECTION

We searched the entire Google Play Store for all the mobile apps with the terms 'Drone', "UAV", 'Drone Controllers', 'Drone Simulators' and 'Drone Games'. We executed a Breadth-First-Search and crawled all the related apps, including their 'docid', 'hreflink', 'developer', 'app price', 'app summary' and 'app score' using an open-source scraper [4]. To get more comprehensive coverage and a large

number of drone apps for the empirical study, the free and paid apps were scraped separately using the price: 'free' and price: 'paid' options in the search method provided by the scraper. A total of 1825 drone apps were collected.

IV. ANALYSIS OF DEVELOPER REPLY

The percentage of developer replies according to their categories is depicted in Figure 1. Below, we analyze each category and provide details of the issues discussed and responded by the drone app developers.

A. Provide Solution

In this category, the drone developer provides a number of steps for the app user to follow and solve the issue. For example:

"*In case of connectivity problems, please make sure no other DJI apps are running in the background. To do so, either restart your phone or go to the settings app/applications and terminate them (closing them with home button is not enough).*"

Often these types of developers' responses are accompanied by direct support mail contact information or forum links, asking the customer to revert if the steps do not solve the issue. For example,

"*Please try the below steps and revert at support@reliancegames.com if the issue persists*

1. Kill/close the game and any unnecessary apps running in the background

2. Free up some space in the device/Clear game cache

3. Reboot/restart your device and launch the game in a strong network (WIFI)"

Many drone app users are concerned with the extent of private information the drone app wants to access, and they feel unsafe about it. Thus, most of the developers' responses in this, i.e., 'provide solution' category, clarify the user, why the drone app needs to collect some of the personal information [3]. Many developers in this category have justified their in-app purchases, informing the users that the in-app purchases were mentioned in the "app description" and directed them to read it.

B. Request Detail

The 'request detail' category makes up 15% of the developer's replies (included in the study). This category includes developer's replies in which they seek more information from the drone app users about the encountered problem. Such as, provide details about their setup, mobile device model, drone

model (e.g., DJI drone model), firmware version (e.g., DJI firmware version) and app version. In order to troubleshoot the drone app users problems, some developers ask functionality queries like: is the user able to launch the app, go past the start-up screen, or is the app freezing while doing so? E.g., "*Hello, please contact support@flylitchi.com so we can help you. Make sure to include details about your setup (mobile device model, DJI drone model, DJI firmware version, Litchi version).*"

A few developers in this category asked the drone app users whether the issues reported happened after an app update. In a few replies, developers requested the drone app users to send all the app's crash logs. Some developers also asked the drone app users to post screenshots or send videos of the issue, e.g., "*Thank you for advising of the experience you encountered Stefanos. Were currently investigating into this occurrence with your device specifications. But if you would be able to provide any screenshots of any error message or disconnected status in the application, please email support@airmap.com!*"

The developers have also asked some users to report their issues to the community forum page, customer care email id, or to their technical support department call facility.

For the app users who have requested a refund for the app, developers have asked them to provide more details, such as their request order number, to initiate the refund process. Similarly, many reviews that mentioned that the drone app needs more improvement, the developers requested the users to: **(a)** Provide more detail on what improvements are to be made and **(b)** Provide/send a concrete suggestion to the support team.

4.3. A Solution in Progress Notification

The comments in this category are the drone app's developer's replies to inform the app users that their engineers are investigating the reported issue(s), and/or a solution is in progress. Around 9% of developer replies belong to this category. Most of the developer's responses in this category state that: **(a)** The next update will fix the issue reported in the user feedback. **(b)** They will consider supporting additional drone models for their app either in the next app update or release. **(c)** They will add compatibility for other/additional devices and android OS versions in a future update.

As a response to *new feature addition* requests, the developers acknowledged the customers for their valuable feedback. They stated that the development team is actively working on the feature addition or would consider their recommendations as they continuously strive to improve their drone app. As for *bug fixes*, most developers apologized for the delay and requested users to kindly extend their patience and follow until the issue was resolved. In case of the *excessive advertisement complaints*, the developers responded that the concerned team is being notified to resolve the issue, e.g.,

"*Thank you for your feedback. The question is under investigation.*"

"*Hello, We do apologize for any inconvenience. We already reported the compatibility and crash issue to the development team, and they are working right now on the application to resolve the issue as soon as possible.*"

"*Kindly extend your patience. Best Regards, Parrot Community Support.*"

C. Offer Refund

A very meager percentage of only 1% of the developer responses offered a full refund to the users who are dissatisfied with the drone app. In some reviews, users have complained that they did not receive a refund. For all such complaints, the developers have asked the users to provide their order number or transaction id since they would not initiate a refund without it. In contrast, a few developers asked for the purchase receipt to be sent to the support via email. Most of the developers who offered a refund (in their replies) were associated with drone education apps where the discontented user reports that the practice questions provided in the app were not helpful and resulted in the user failing the drone pilot exams. In the case of *device incompatibility issues,* the developer in their response apologized to the customer, offering a refund and stating that it is impossible to provide support for all the varieties of drones or devices present in the market, e.g., "*One star? If it's that bad send me an email. More than happy to issue a refund.*"

"*Please contact us at support@appologics.com and we can help you with issues or re-fund.*"

D. Offer Direct Support

In response to negative user feedback, most of the developers offered direct support (35%) i.e., asked users to contact them directly (through the contact details provided instead of reporting app issues in the Google Play Store platform) so that they can guide them on how to use certain features of the app. In cases, where the developers could not provide direct support (due to company policies), all of them apologized to the user for the unpleased experiences they incurred with the drone app. Further, developers guided the users through possible options to receive support, such as listing the steps to report their issues to the technical support team via support mail id (e.g., support@flylitchi.com), or phone number of a support forum community (e.g., https://www.facebook.com/spacewargame) or relevant website (e.g., https://www.parrot.com/support/hotline) where the user can report their issue with details to the support executive and receive immediate solutions to their issues, e.g.,

"*Please contact support@flylitchi.com so we can help you fix this.*"

"*Hello, users, you can consult. jov@simtoo.com Thank you~*"

E. Solved Notification

Solved Notification Category includes all the developer responses/comments aimed to notify the drone apps users that the issue reported in their review (negative feedback) has been solved. Among all the developer replies, only 9% of replies belong to this category, which implies that drone developers do not solve customers' issues actively, or they take too long to respond, or they do not bother to notify the user even after the issue is solved. Among all the developers who reply in this category, 82% of replies were to notify that their reported problem was solved as part of a new release of software and the user needs to upgrade to the new version, e.g.,

"Thanks for your review. There was a bug. I just uploaded an update (version 2.4.1), which fixes it again."

Only 6% of the developer's replies in the category include a notification to the user that their issues have been explicitly taken care of. In all such responses, the developer advised the users to log out of the drone app and log back in for new changes to come into effect.

"We appreciate your patience during this fix Chris. I am happy to report that the Air-Map application is currently functioning properly and displaying airspace information when selecting a particular gridded area for recreational and commercial operators. Fly Safe!"

Some developer responses in this category, i.e., 4%, advise users that the issue reported is tied to the old version of Android OS, not the mobile drone app. Updating to the new/latest Android OS update will resolve their issues. The remaining 9% of the developer replies in this category include: (a) Notifying drone app users of added support for new drone models or new phone compatibilities as requested by them (b) Apologizing to the drone app users for the service outage and notifying that the service has rebounded and (c) Expressing regret for the delay in responses since the app improvisation was a major update.

F. Others

Almost 12% of the developer responses could not be classified into any of the above five categories due to their arbitrary nature of responses. For example, many of the developer replies were not in regard to addressing any of the user's top-27 complaints, as shown in Figure 4, rather simply thanking and appreciate the users for their feedback. For most of the good reviews in 3-star rating comments, which did not specifically mention any complaints but just appreciated the app, the drone developer replies to express their gratitude and explicitly asked the happy and satisfied users to consider giving their drone app a 5-star rating. A few responses of the drone developers in this category stated to the user that the issue reported by them is not caused by the drone app; indeed, it's their phone's hardware issue. Some developers' (3%) provided users with a harsh response. However, analysis of the developer's replies yields that 6% of the developer's replies in this category are counter-replies, apologizing for the inconvenience caused by the drone apps (such as by the Parrot SA developers).

6. Conclusion and Future Work

This paper is a large-scale empirical study of UAV or drone-related apps of the Google Play Store Platform. The study consisted of 1,825 UAV mobile apps, across twenty-five categories, with 162,250 reviews. We find that most top drone apps do not respond to reviews. However, responding can lead to a positive change in rating. Addressing specific issues and notifying the users that requested features are available are most likely to lead to a change in the review rating. As future work, we plan to undertake the following tasks: (a) identifying the stakeholders of the reviews and perform review analysis on the individual stakeholder perspective, (b) perform similar review analysis on UAV or drone-related apps of other mobile app platforms such as the iOS store, Blackberry World, and (c) Apply machine learning on the manually categorized user

reviews to enable the automatic classification of upcoming new user feedback into their respective complaint types.

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