Towards Understanding an Open-Source Bounty: Analysis of Bountysource

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***Abstract*—When developing and maintaining a software project, many issues about bug fixing or feature addition are reported on the Bug Tracking System (BTS) and the Issue Tracking System (ITS). Bountysource is a web founding platform that awards developers who have solved issues on the BTS/ITS. Users can post a bounty for the issues, and a developer who solves the issue can get that bounty. This research analyzes Bountysource to clarify how bounties act in open source software projects and discusses further research topics in open-source bounties.**

I. Introduction

For the sustainability of open source software (OSS) projects, retaining contributors and attracting new contributors is an important. There are a variety of ways of contributing. If the project uses a bug tracking system or an issue tracking system (BTS/ITS), people can report an issue, join a discussion on bugs, or write code to solve an issue, for example.

Traditionally, the major motivation for becoming involved in OSS communities has been learning [1]. Nowadays, however, the motivations for contributing to OSS projects have become diverse. To encourage external contributors to join a software development project, a bounty program awards developers who find a vulnerability, fix a bug, implement a new feature.

In this research, we focus on Bountysource [2], a web-based platform that allows users to post a bounty on issues reported in BTS/ITS,

The following is an example flow of how a bounty is posted and paid out.

- A backer (either a person or a team) posts a bounty to an issue in which the backer has an interest.
- A bounty hunter writes code to solve the issue and posts a pull request. After the pull request is merged, the issue is closed.
- The bounty hunter claims a bounty with a link to the code which is merged.
- If the claim is accepted by the backer, or two weeks passed without a rejection, the bounty is paid to the bounty hunter.

Giving incentives to developers is important, but the exact effectiveness of bounty-based development has not been fully revealed yet. Therefore, we investigate the use of Bountysource to clarify how bounties act in OSS projects.

II. Current Analysis Results

We analyzed data as of November 2016, which was collected from a Bountysource website and its APIs. We collected all posts in the Bountysource. There are 6,280 bounty posts in total and 2,638 of the posts ware paid out to bounty hunters. The oldest bounty was created in September, 2012, when the current Bountysource service was launched. Each issue has two statuses: open or closed. We limited the target to projects using GitHub as its ITS to get exact data on each issue such as its open and close date.

We analyzed the top 50 projects in order of total bounty amount. Because some of the data we collected was broken, our final project total was 31 projects. Table I shows a summary of all issues extracted from those 31 projects. We use the term "HB" for the issues having bounties, "NB" for the issues not having bounties, and "closed rate" for the number of closed issues per the number of total issues.

In addition, we chose the top two projects from the total number of the bounty posts. The first project is a Bountysource web platform project[1]. Table II shows a summary of issues linked to the Bountysource platform. We also analyzed an OpenRA project[2], an open-source game developing project for the second example. Table III shows a summary of issues linked to the Bountysource platform.

A. Are the issues solved with bounties more likely to be closed?

From Tables I, II, and III, we see that the number of HB is less than that of NB. Data also shows that the closed rate of HB is relatively lower than that of NB. However, in both the Bountysource project and the OpenRA project, the closed rate of HB approaches that of NB. Since "closed" does not always mean "the feature is added" or "the bug is fixed", we must also consider the case where the issue is closed due to rejection, which may raise the closed rate of NB.

B. Are issues with bounties solved more quickly than issues without bounties?

Figure 1 shows a boxplot comparing HB and NB from the period when the issue was created to when it was closed.

[1]https://www.bountysource.com/teams/bountysource/issues?tracker_ids=47
[2]https://www.bountysource.com/teams/openra/issues?tracker_ids=36085

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TABLE I
31 PROJECTS ISSUES SUMMARY

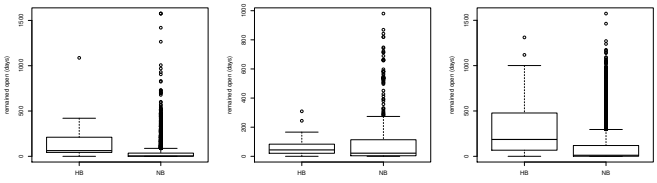
31 Projects	open	closed	Total	(closed rate)
NB	3468	5559	9027	(61.6%)
HB	84	36	120	(30.0%)
Total	3552	5595	9147	

TABLE II
BOUNTYSOURCE PROJECT ISSUES SUMMARY

Bountysource	open	closed	Total	(closed rate)
NB	243	514	757	(67.9%)
HB	16	31	47	(66.0%)
Total	259	545	804	

TABLE III
OPENRA PROJECT ISSUES SUMMARY

OpenRA	open	closed	Total	(closed rate)
NB	1098	3895	4943	(78.8%)
HB	50	75	125	(60.0%)
Total	1048	3970	5068	



(a) 31 Projects (b) Bountysource (c) OpenRA

Fig. 1. Period from when the issue was created to when it was closed.

Among the 31 projects, the average period of HB is longer than that of NB (Wilcoxon rank sum test, $p < 0.01$). We got the same result for the OpenRA project. In the Bountysource project, the average period did not differ much respective to bounties ($p = 0.0646$). Some NB took more than one year to close, but such cases cannot be found in HB.

Considering the closed rate, bounties appear to be posted on issues that are difficult to solve. However, some NB might close quickly because of false bug reports or feature requests that are rejected, so the average period for NB tends to be lower than HB.

C. How do major backers use Bountysource?

We also analyzed backers, who post a bounty to issues and support projects. We investigated the details of the top three backer teams: IBM, ripple, and elementary, by the total amount of bounties. We also added a Bountysource team as a reference. Table IV shows a summary of the bounties made by those four teams.

The average amount of the bounty from IBM is larger than that from the other backer teams. Issues to which IBM posts a bounty are mainly requests for feature additions or fixes for specific architectures. This type of bounty seems to be directed toward hiring a developer rather than awarding a bounty hunter.

TABLE IV
SUMMARY OF BOUNTIES MADE BY TOP 3 TEAMS AND BOUNTYSOURCE TEAM

Team	#Projects	#Bounties (own project)	Ave.	Max.
IBM	27	86 (0)	$2,952.30	$11,500
elementary	52	463 (77)	$46.72	$500
ripple	1	109 (109)	$251.64	$4867
Bountysource	13	52 (36)	$83.24	$1,000

D. Other findings

We also found a case where the discussion was restarted after the first bounty was added when the issue had been left without discussion for a long period. This kind of bounty would suggest to developers that there is still a demand for the issue to be solved. On some issues, the bounty is made after the pull request is merged. This may suggest that the developers are thanked and rewarded rather than a call being made for bounty hunters to solve an issue.

III. FURTHER APPROACHES

We would like to continue this analysis and investigate whether the bounty program motivates developers to join OSS development, fix bugs, to add features.

We are planning to categorize the issues and compare the effect of the bounties, for example, bounties for bug fixes versus bounties for feature additions. Existing research about the analysis of security fixes and bug bounty programs exist [3], [4]; we would like to compare the result of an analysis of Bountysource with that of bug bounty programs for security vulnerability.

Considering the current use of Bountysource, an uncovered model for bounty-based development still exists. For example, a bounty is paid only to a developer who posts a final version of the solution. When an issue is posted to BTS/ITS, a discussion occurs and then someone will do the implementation. Measuring the contribution of all contributors in the discussion and awarding them will be the next step of bounty-based development.

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REFERENCES

[1] Y. Ye and K. Kishida, "Toward an understanding of the motivation open source software developers," 2003, pp. 419–429.
[2] Bountysource. [Online]. Available: https://www.bountysource.com/
[3] M. Zhao, J. Grossklags, and P. Liu, "An empirical study of web vulnerability discovery ecosystems," in *Proc. CCS '15*, 2015, pp. 1105–1117.
[4] N. Munaiah and A. Meneely, "Vulnerability severity scoring and bounties: why the disconnect?" in *Proc. SWAN 2016*, 2016, pp. 8–14.