# An Empirical Study of Technical Debt Management as a Motivation for Forking

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***Abstract*—Forking is an often used idiom in software ecosystems that allows for the immediate reuse of existing software packages. Further, research shows that forking negatively impacts software quality since it distributes the maintenance effort across several repositories. However, there is a lack of sufficient knowledge exploring the validity and applicability of forking as an approach to solve software quality issues. In this position paper we present a plan to investigate the effectiveness of forking in managing technical debt.**

***Index Terms*—Forking, Software reuse, npm, SonarQube, Technical debt**

## I. Introduction

Software product line approaches advocate for strategic, planned reuse that yields predictable results. In practice though product variants often emerge ad-hoc, when companies have to release a new product that is similar, yet not identical, to existing ones [1]. To implement new product functionality, developers often fork an existing product code base and modify it to fit new requirements using the "clone-and own" approach [2]. Forking the code base allows developers to leverage existing functionality while also addressing new requirements [3].

Open source software provides an existing code base that acts as a starting point for software developers to reuse and create a software variant by forking an existing project. Prior work has shown that code reuse can be beneficial in reducing the time-to-market, improving software quality and boosting overall productivity [4], [5]. Thus, package management platforms such as npm have emerged to encourage reuse and facilitate code sharing through packages or modules that are written using popular platforms such as Node.js [6], [7].

First, developers may fork mainlines with a large amount of technical debt so that they address that technical debt and send back the contributions to the mainlines (these kind of forks are called social forks [8]). However, previous research shows that some projects do not easily accept contributions into their repositories [9]. When the contribution is rejected, the fork developer may end up maintaining the fork and in the end it evolves into a variant of the mainline with variant specific code. In fact Zhou et al. [10] reports that many variant forks actually start as social forks.

In addition to the aforementioned motivations and benefits, forking negatively impacts software quality since it distributes the maintenance effort across several repositories. High quality code is characterised by low maintenance costs and allows for the fast integration of new team members. One of the impediments to software quality is technical debt. "Technical debt refers to a collection of design or implementation constructs that are expedient in the short term, but set up a technical context that can make future changes more costly or impossible. It presents an actual or contingent liability whose impact is limited to internal system qualities, primarily maintainability and evolvability" [11].

Literature often mentions the pitfalls and dangers of forking [12], [13]. In this paper we present a research plan to investigate whether there exists any positive impact of forking on technical debt and whether technical debt management was the motivation for forking in the first place. The remainder of this paper is organized as follows. Section II summarizes the background information and related work are provided. Section III presents the study design to be applied. Section IV presents a discussion of the expected results and future work.

## II. Background

Researchers have collected a large body of knowledge on forking and it's motivation and impact. Robles et al. performed an in depth study on several hundred forks and reported on the date when the forking occurred, the reason of the fork, and the outcome of the fork in order to see if forking undermines the sustainability of the projects [14].

Nyman et al. report on the possible benefit of forking serving as an invisible hand in the long term sustainability of software projects and safeguarding against unfavorable decisions from a single developer or organization [15], [16].

Viseur reported on a detailed study of twenty six open source projects highlighting the motivations and impact of forking [17]. They found that the main motivations of forking are technical divergences, governance mismatches, end of the original project, license change, conflict about trademark and strong cultural differences.

Businge et al. performed an exploratory study on clone-based reuse practices for open-source Android apps [18]. They found that the motivations for the fork variants were re-branding and simple customisation, feature extensions, supporting of the mainline and development of different, but related features.

Jing et al. explore why and how developers fork what and from whom in GitHub [19]. From their study they found that the reasons developers fork projects are to submit pull requests, add new features, fix bugs and keep copies of the original repository.

Ernst et al., addressed the question of whether requirements were a basis for a fork and they hypothesized that forking was required to address the soft goals of maintainability and usability [3]. They confirmed that indeed the fork had a better code base and also satisfied the soft goals of usability and maintainability. Maintainability is one of the technical debt measurement metrics that result from an analysis of technical debt by some of the leading tools for continuously inspecting code quality. This study therefore finds that forking impacted the technical debt accrued in the projects.

We will substantiate this finding and check whether forking has a positive impact on other technical debt measurement metrics such as reliability, complexity, security, among others.

## III. Empirical Study Design

We follow a mixed method approach to examine the relationship between forking and technical debt. First, we mine and analyse mainline forks from npm and later perform a confirmatory analysis using a survey of the maintainers and contributors of the forked projects.

### A. Goal and Research Questions

The goal of the study is to investigate whether forking and the creation of forked product variants positively impact technical debt and whether that was intentional. To this end, we plan to answer the following research questions.

- RQ1: Is there a relationship between the amount of forking (number of forks in a project) and the amount of technical debt in the project?
- RQ2: How do open-source contributors perceive forking as a way to manage technical debt?

### B. Study Setup and Data Collection

To perform our study, we obtained a dataset of Node.js packages from the npm registry on which we perform technical debt analysis using the community edition of SonarQube.

Since its inception, npm has grown to become one of the largest software ecosystems [20], [21]. We chose npm for the following reasons: it provides API access to all package releases and metadata, most npm packages point to a GitHub repository and the npm registry and GitHub both show the package's README file, providing a common place where more information is displayed. Moreover, the npm community is innovation friendly and broadly experiments with and adopts developer services including cloud-based continuous integration [22], [23].

SonarQube claims to be one of the leading tools for continuously inspecting code quality and security and guiding development teams in code reviews [24]. SonarQube calculates several metrics such as: lines of code, complexity, coverage, false positive issues, code smells and vulnerabilities. The analysis is violation-based and examines the health of the code according to a set of rules. If the code violates these coding rules, SonarQube reports this as an 'issue'. These are some of issue domains in SonarQube [25]:

- Maintainability: maintainability issues are reported as 'code smells' which may need to be addressed in the future.
- Reliability: Referred to as bugs in the code, reliability issues are critical programming errors that can trigger run time failures.
- Security: referred to as vulnerabilities, are flaws in programs that can lead to misuse and exploitation of the application.

For the purpose of our work, we are interested in studying the following two concepts as they relate to technical debt and the evolvability of the packages we will analyse from npm.

- Code smells which are a maintainability issue that makes the code difficult to maintain in the long run and increase the overall technical debt.
- Bugs: issues that throw an error during run-time should be fixed as soon as possible.
- Flaws and their impact on security

**RQ1.** To address the first research question, we collected a data set of npm packages by mining all npm packages then kept only those that had at least two forks, contained metadata on dependencies, dependents, and maintainers and had a link to a GitHub repository. We are currently implementing a SonarQube scanner pipeline to analyse our dataset and provide us with the technical debt measurements we require to test our hypothesis. The results from the SonarQube analysis will be collected in an Excel file. We will apply open coding to these results to explore the relationship between forked packages and the amount of technical debt.

**RQ2.** To answer research question two, and gauge developer perceptions we will perform an online survey targeting npm maintainers and contributors of the most active packages. We have a cut off period of 100 days of updates given that developers may clearly recall their reasoning behind intent of code, data modified in code, owners of files, files that rarely/often changed, recent changes etc within that time period following work done by Kruger et al. [26]. Moreover to support RQ1, we will also ask whether the maintainers and contributors of the packages we study had the intention of solving any vulnerability, security or maintainability issues while performing the forks.

## IV. Expected Results

As we report on our findings about the intersection between forking, variants and technical debt, this work will be useful in generating knowledge about the problem where the literature

does not provide much insight. We will report on the amounts and types of technical debt contained in the npm packages and Github repositories we study. In addition, we will motivate the need for more studies on the nature of requirements in forking and whether requirements are a justification for forking.

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