

# The Pot of Gold at the End of the Rainbow: What is Success for Open Source Contributors?

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**Abstract**—Success in Open Source Software (OSS) is often perceived as an exclusively code-centric endeavor. This perception can exclude a variety of individuals with a diverse set of skills and backgrounds, in turn helping create the current diversity & inclusion imbalance in OSS. Because people's perspectives of success affect their personal, professional, and life choices, to be able to support a diverse class of individuals, we must first understand what OSS contributors consider successful. Thus far, research has used a uni-dimensional, code-centric lens to define success. In this paper, we challenge this status-quo and reveal the multi-faceted definition of success among OSS contributors. We do so through interviews with 27 OSS contributors who are recognized as successful in their communities, and a follow-up open survey with 193 OSS contributors. Our study provides nuanced definitions of success perceptions in OSS, which might help devise strategies to attract and retain a diverse set of contributors, helping them attain their “pots of gold at the end of the rainbow”.

**Index Terms**—open source software, success, career, qualitative analysis

## 1 INTRODUCTION

Success in Open Source Software (OSS) encompasses much more than code contributions alone; In the words of one of our participants: Success in OSS is “*contributing more than code, [and involves] contributing documentation, processes ... the governance of the project*”. However, currently there is a misperception that being successful in OSS is determined by programming skills [1]. This perception is promoted in how projects highlight programming-related metrics on their sites (e.g., number of lines of code, number of commits) and in how they determine advancement in roles (e.g., becoming a core member/maintainer, gaining commit access)—all code-centric concepts [2, 3]. Academic research has also, perhaps inadvertently, added to this misperception, as past studies have largely been code-focused. An example is the numerous papers recognizing the “onion model” as the mechanism through which contributors join, grow, and receive *commit access* to the code repository [4, 5, 6, 7].

OSS contributors, however, comprise an heterogeneous group, with differing talents, skills, career goals, and motivations [8, 9, 10, 11]. Some perform a variety of non-code related activities (e.g., advocacy, technical writing, translation, project management) [1, 12] and follow a much different pathway than the celebrated “onion model” [1, 13, 14].

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Given the fact that OSS communities involve many more players than simply their “code warriors”, the definition of success must be broadened beyond the quantity of code one produces.

The way we define success has a remarkable impact on the choices we make in our personal and professional lives. Definitions of success can affect our educational choices, decisions of where to work, project involvement, career attainment, life satisfaction and so on [15]. Therefore, it is important to create a comprehensive understanding of the multitude of factors that underpins what success means to an individual in OSS. Without such an understanding, how can OSS communities support diverse individuals whose background, career goals, and pathways do not fit the typical onion model career mold?

In this study, therefore, we tackle the fundamental question: **RQ**. What does it mean to be successful in OSS?

To answer this question, we interviewed 27 OSS contributors who are recognized as successful figures in their communities. We qualitatively analyzed the interviews by using as a lens the “success model” proposed by Dries et al. [16]. We then triangulated our results with data from a survey of 193 OSS contributors.

Our results indicate that the definition of success is multi-faceted and nuanced. It includes both objective perspectives (e.g., monetary compensations, amounts of contribution) as well as subjective perceptions (e.g., recognition in the community, satisfaction). And while the end goal of contributors can be similar, how they go about being successful can be very different for different people and is rooted in their perceptions of what success means to them.

In the words of von Krogh [10]: “*Occasionally, humans also make elaborate detours, strive for bigger things in life, and undertake long voyages to find the gold at the end of the rainbow.*” Thus, it is time that we reflect on what we consider as success in OSS, and how we can help make OSS diverse by

finding different ways to support diverse individuals with diverse backgrounds and motivations and who have diverse definitions of success.

## 2 DEFINING SUCCESS

Success can be defined as “the accomplishment of desirable work-related outcomes at any point in a person’s work experiences over time” [17] and is a dynamic concept [18]. Existing literature shows that career success can be characterized from different perspectives, such as: job, interpersonal, financial stability, and life success [19]; balance, relationships, recognition, and material success [15]; psychological, and social career success [20]; and extrinsic and intrinsic success [21].

Dries et al. [16] created a comprehensive multidimensional theoretical model to explain success, which encompasses several concepts from the other studies [15, 19, 20, 21, 22, 23, 24, 25, 26, 27] (Figure1).

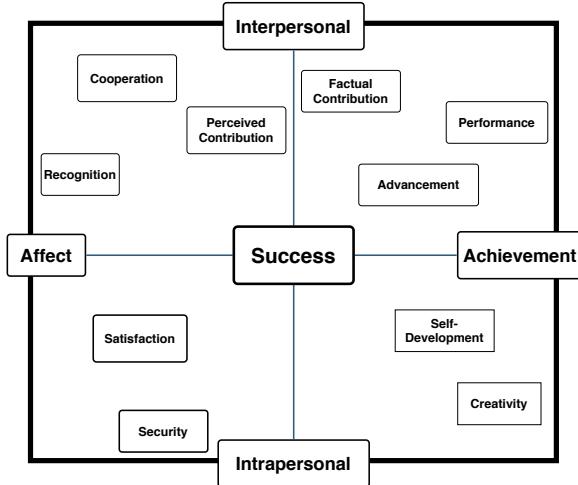


Fig. 1. The multidimensional model of success [16]

This model comprises two dimensions, and further classified into four quadrants, and ten regions. The first dimension is *Affect* × *Achievement*. *Affect* represents the subjective side, the feelings and perceptions that cause people to weigh their success as high or low. *Achievement* represents the objective side: the factual accomplishments through which people measure their success.

The second dimension is *Interpersonal* × *Intrapersonal*. *Interpersonal* represents actors’ relationships and interactions with the outside world. *Intrapersonal* represents the actor’s “self”, their internal world. The combination of these two dimensions (*Affect* × *Achievement* and *Interpersonal* × *Intrapersonal*) generates four quadrants: (Quad1) *Interpersonal* × *Affect*; (Quad2) *Interpersonal* × *Achievement*; (Quad3) *Intrapersonal* × *Achievement*; (Quad4) *Intrapersonal* × *Affect*. The multidimensional nature of this model shows how success can have several different—yet complementary—meanings that may serve people with different goals.

Akkermans and Kubasch [28] explain that careers have been changing in the past decades—evolving into more complex and unpredictable endeavors—that require empirical

studies in different domains to understand success. We use the above model to analyze the definition of success in OSS.

## 3 RESEARCH DESIGN

This section presents the design of our study, which included interviews and a survey, as depicted in Figure 2.

### 3.1 Interviews: Building the OSS Success Model

Due to the complexity of the phenomenon under study, we started with in-depth interviews to understand how OSS contributors perceive success.

#### 3.1.1 Interviews Planning

For the interviews, we aimed to recruit recognized OSS contributors to understand successful OSS career stories. We started by recruiting invited speakers of the Open Source Software Conference (OSCON-2019), a well-recognized open source conference focused on practitioners. These speakers were invited to give talks in the main lineup of the conference and, arguably, are successful in OSS.

Before OSCON started, We emailed and sent direct messages via Twitter to all panelists whose contact information was publicly available (15). We also approached some of them during the event. We conducted face-to-face interviews with 11 people who agreed to be interviewed. In addition, we used a snowball approach to recruit more interviewees. At the end of each interview we asked them to introduce us to other qualified participants for the study. We conducted 4 additional interviews from this snowballing approach. A majority of our interviewees were women, possibly because they cared about our goal to investigate diversity and inclusion in OSS. This initial imbalance was counterbalanced in the subsequent interviews (see Table 2).

After this first cycle of interviews and analysis, given the gender imbalance in our dataset, we recruited 12 additional participants. We invited maintainers of mature OSS projects who could share their perspectives of contributing to OSS. In both phases of interviews (at OSCON and post event), we used a snowballing approach: at the end of each interview, we asked interviewees to introduce us to other qualified participants for the study, aiming to reach other speakers and successful project maintainers. Our goal was to interview experienced contributions working at least 5 years in well-known and mature OSS projects. We compensated interviewees with a 25-dollar gift card.

Before interviewing participants, we conducted five pilot interviews with a professor and four PhD students who were experienced in OSS. The goal was to solicit feedback on the script and ensure that the interview would fit in a 40- to 60-minute time slot. We analyzed the pilot interview responses to ensure that we answered our research question with an adequate level of detail.

We conducted semi-structured interviews [29]. We used a script as we present in Table 1 to guide the different areas of inquiry, while also listening for unanticipated information during the flow of the conversation. The interviews revolved around the central question: “*How would you define being successful in Open Source?*” We approached this topic after establishing rapport with the interviewee, asking about their career story and contributions.

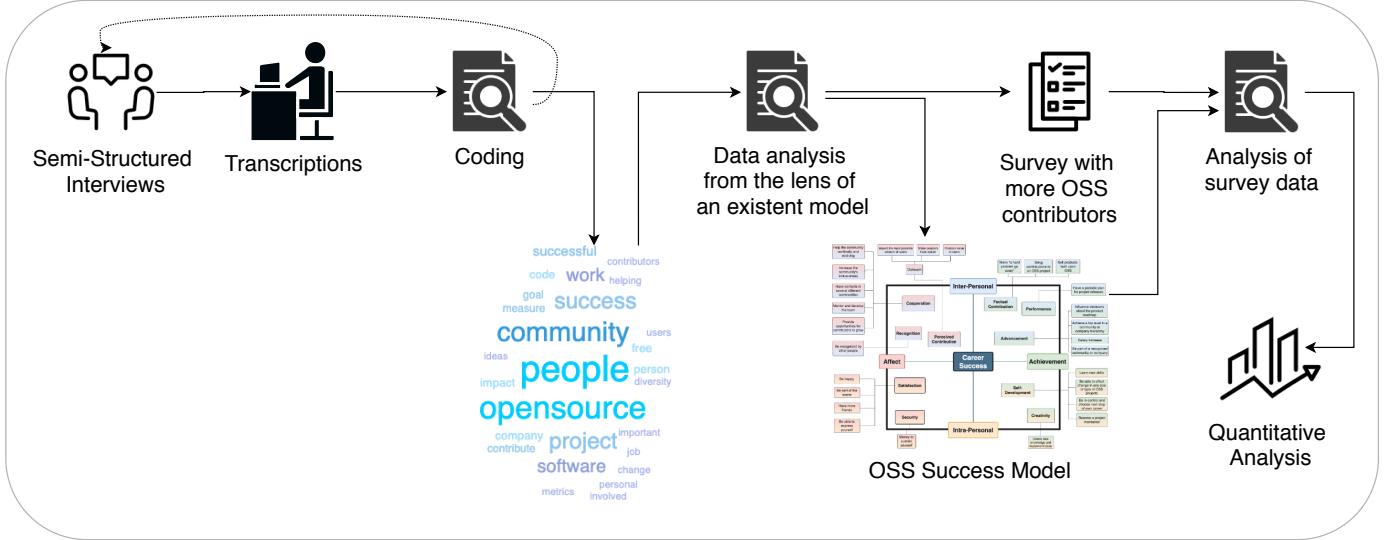


Fig. 2. The research method, which included face to face interviews at the OSCON'19 event and later with OSS maintainers through video conferencing, as well as a large-scale survey. We conducted qualitative analysis to build the OSS Success Model and qualitative and quantitative analysis to triangulate the definition of success we found from the interviews' data

TABLE 1  
Interview Script and Survey Questions (excluding demographic questions)

Interview Script
I-1. Can you please tell me all the story of your career? All your professional journey, from the beginning of your career until where you are today
I-2. How would you define yourself as being a successful OSS contributor?
I-3. Is there any kind of success that you didn't achieve yet? What do you plan to achieve in the future?
I-4. Please think about a person you consider successful in OSS. Why do you think this person is successful?
I-5. Now the opposite. Please think about a person you consider not successful in OSS. Why do you think this person is not successful?
Survey Questions
S-1. Do you consider yourself a successful OSS contributor? (Yes/No/I don't Know)
S-2. How would you define a successful person in F/OSS? (Open Question)

We interviewed participants until we could not find any new concept related to our research question for five consecutive interviews. Our final sample comprised 27 participants. Table 2 presents their demographics.

### 3.1.2 Data Collection

Five researchers participated in performing the interviews, where there were at least 2 researcher per interview. The researchers have at least six years' experience in qualitative studies. The interviews were face-to-face during OSCON and over video conference calls afterward. Interviews lasted between 40 and 60 minutes. With participant consent, we recorded all interviews. The first author of this paper transcribed the interviews for the analysis.

Our sample comprises paid and volunteer contributors across 20 different OSS projects (e.g., Kubernetes, Drupal, R, Noosfero, Fedora, Debian, GitLab), which vary in terms of number of contributors (30 to 3,000 contributors), product domains (including infrastructure and user-application projects), and types (backed by foundations, communities, and companies). Table 2 presents the demographics of our sample. Because of the terms of consent, we cannot link each participant to their projects.

### 3.1.3 Data Analysis

The data analysis was performed in two stages. In the first stage we analyzed the interview data collected at OSCON 2019 and in the second stage we analyzed the data from the additional interviews. We qualitatively analyzed the transcripts of the interviews by inductively applying open coding in groups, where we identified the definition of success that each participant provided. We built post-formed codes as the analysis progressed and associated them with respective parts of the transcribed text, so as to code the success definitions according to the participants' perspectives, who were identified as P1 to P27.

Researchers met weekly to discuss the coding. We discussed the codes and categorization until reaching consensus about the meaning of and relationships among the codes. The outcome was a set of higher-level categories as catalogued in our codebook<sup>1</sup>.

To organize our categories according to Dries et al.'s model [16] (see Section 2), three of the authors conducted multiple card sorting sessions [30], arranging the codes according to the dimensions and regions of the model. More specifically, for each category, we analyzed the definitions of each region of the model and discussed until we reached

1. <https://figshare.com/s/39491da83e398612dff>

TABLE 2  
Demographics for the Interview Participants

Participant ID	Gender	Years in OSS	Main Type of Contribution	Recruitment	Interview Mode
P1	Woman	6	OSS Advocate	OSSCON Speaker	In-person
P2	Woman	5	OSS Coder	Mature project	Video-conference
P3	Woman	13	OSS Treasurer	OSSCON Speaker	In-person
P4	Man	9	OSS System Admin	OSSCON Speaker	In-person
P5	Prefer not to say	7	OSS Coder	OSSCON Speaker	In-person
P6	Man	5	OSS Coder	OSSCON Speaker	In-person
P7	Man	12	OSS Coder	OSSCON Speaker	In-person
P8	Woman	30	OSS Strategist	OSSCON Speaker	In-person
P9	Man	13	OSS Advocate	OSSCON Speaker	In-person
P10	Woman	20	OSS Advocate	OSSCON Speaker	In-person
P11	Woman	20	OSS Writer	Snowballing	Video-conference
P12	Woman	20	OSS Advocate and Writer	OSSCON Speaker	In-person
P13	Woman	7	OSS Advocate	Mature project	Video-conference
P14	Woman	20	OSS License Manager	Mature project	Video-conference
P15	Woman	15	OSS Advocate	OSSCON Speaker	In-person
P16	Woman	10	OSS Advocate	Snowballing	Video conference
P17	Woman	5	OSS Project Manager	Snowballing	Video conference
P18	Man	8	OSS Coder	Mature project	Video-conference
P19	Man	8	OSS Coder	Mature project	Video-conference
P20	Man	5	OSS Coder	Mature project	Video-conference
P21	Man	15	OSS Coder	Mature project	Video-conference
P22	Man	10	OSS Advocate	Mature project	Video-conference
P23	Man	7	OSS Coder	Snowballing	Video-conference
P24	Man	20	OSS Coder	Mature project	Video-conference
P25	Man	23	OSS Coder	Mature project	Video-conference
P26	Prefer not to say	10	OSS Project Manager	Mature project	Videoconference
P27	Woman	10	OSS Coder	Mature project	Video-conference

consensus on how to classify the category. The analysis used the process of continuous comparison [31].

### 3.2 Survey: Data Triangulation

Next, we conducted an online survey to triangulate the interview results by gathering data from a different perspective [32] and a larger sample.

#### 3.2.1 Survey Planning

In the survey, we asked two key questions about participants' perceptions of success (see Table 1), and additional demographic-related questions, including the relationship with OSS (paid/unpaid), types of contributions, gender identity, country of residences, and age. The target population included any person who contribute to OSS.

We advertised the survey on social media and community blogs (e.g., LinkedIn, Twitter, Facebook, Reddit, Hackernews, CHAOSS blog, and others). To reach a broader audience, we paid to promote our posts on Twitter, Facebook, and Reddit. We also sent direct messages to OSS contributors and discussion lists.

#### 3.2.2 Data Collection

The survey was available between June 4<sup>th</sup> and July 3<sup>rd</sup>, 2020. We received 217 non-blank answers. We inspected these answers and removed 25 that did not provide a relevant answer (e.g., "I don't know", "I don't want to answer"). The final analysis included 193 answers.

We asked participants their three main types of contributions and classified participants as "coder" if they selected "code developer" or "code reviewer" as one of the three main types of contributions. We classified as non-coders

those who selected only a subset of these options: translation, documentation, mentorship, user support, community building, bug triaging, event presentations, advocacy and evangelism, creative work and design, and project management. We present the demographics of the survey participants in Table 3.

TABLE 3  
Demographics for the Survey Respondents

Type of Contribution	#	%	Country of Residence	#	%
Coder	163	84.46%	Germany	89	46.11%
Non-Coder	30	15.54%	USA	59	30.57%
Gender	#	%	Netherlands	12	6.22%
Men	165	85.49%	Brazil	9	4.66%
Women	16	8.29%	Others	23	11.92%
Non-Binary	2	1.04%	Did not answer	1	0.52%
Did not answer	10	5.18%	Age	#	%
Financial Relation	#	%	24 or less	30	15.54%
Paid	36	18.65%	25-34	60	31.09%
Unpaid	137	70.98%	35-44	59	30.57%
Partially Paid	16	8.29%	45-54	27	13.99%
Did not answer	4	2.07%	55 or more	10	5.18%
Do you consider yourself a successful OSS contributor?	#	%	Did not answer	7	3.63%
Yes	72	37.31% <sup>^</sup>	Yes	72	37.31% <sup>^</sup>
No	80	41.45%	No	80	41.45%
I'm not sure	41	21.24%	I'm not sure	41	21.24%

#### 3.2.3 Data Analysis

We qualitatively analyzed the answers to the open-ended questions using the existing codebook from the interview stage. We use descriptive statistics to summarize the survey responses, their association with each other (success constructs) and the demographics data [33]. We use the chi-square test at  $\alpha = .05$  and Yates and Bonferroni corrections to investigate any statistical relationship between the different analysis constructs.

See supplemental for additional details of our analysis, including sample answers to the demographics and open question survey questions, the qualitative analysis codes, as well as details of the chi-square tests.

## 4 RESULTS

In the following, we present our participants' definitions of success.

### 4.1 Understanding Success in OSS

Our analysis of the interviews (see Section 3.1.3) revealed 26 categories that explain how our participants defined success. We organized these categories using the multidimensional model of success proposed by Dries et al. [16] (see Section 2), as can be seen in Figure 3. The 26 categories covered all ten regions of the model. Table 4 presents the number of participants (interviews and survey) whose responses fit in each region. The survey analysis did not provide any new definitions of success. In the following, we present our findings organized by quadrant.

#### 4.1.1 Quad1: Interpersonal × Affect

The first quadrant in Dries et al.'s model [16] is defined by two dimensions: (1) Interpersonal, which represents an individual's relationships with the outside world and (2) Affect, which represents internal feelings and perceptions that characterize success. This quadrant contains three distinct regions of meaning: Cooperation, Perceived Contribution, and Recognition.

COOPERATION (Figure 3.I(a)) is defined as working with others (peers, superiors, subordinates, clients, etc.). The collaborative nature of OSS relates to this region as OSS contributors work together, support their community, and help their peers. In our analysis, we identified five categories which we explain next.

Success included building social capital, i.e., "having contacts in several communities" as it allows identifying sources of help quickly when necessary (P8, P17, P21). It also includes being able to contribute to "community sustainability", so it can be "as great as it can possibly be" (P3) and "more diverse and more inclusive" (P13). "Bringing people together" (P8) to increase the community's inclusivity was also repeatedly mentioned as a factor of success. Participants often mentioned individual success as part of the community's success: "having a healthy community is probably the most important thing" (P4) and "the sign of a healthy open source project is where everybody feels like their voice is heard and their opinion matters" (P7).

The cooperation aspect of OSS was also highlighted when participants defined their success as the ability to support others' success by "providing opportunities for contributors to grow" (P7) and "become more present and productive" (P15) by "giving everybody the opportunity [to climb] the contributor ladder" (P7).

Participants also cited success as being a *mentor* who is "friendly, didactic, and receptive to increase contributions" (P2 and P20), "who [neither] burn themselves out, [nor act as] the hero in the situation" (P15). An OSS mentor plays a crucial role in collaborative communities and influences the

degree to which a newcomer relates to an OSS community and identifies with it [12]. Indeed, our participants mentioned that newcomers need to "feel they are heard" (P3), and that successful mentors *develop the team* by "let[ting] people participate" (P4) and "being open to new ideas, whether that could be coding, helping to figure out what the roadmap is, identifying features, identifying bugs, kind of all those things coming together" (P4).

PERCEIVED CONTRIBUTION (Figure-3.I(b)), according to Dries et al. [16], equates with serving society. In the context of OSS success, our participants mentioned perceived contribution from the perspective of *outreach*—i.e., "impact on people in the world" (P11). Participants considered themselves as successful when the product they contribute to has "high adoption" (P9), "produce[s] value for the people" (P17), "leave[s] a legacy" (P25), and makes people's lives easier" (P5).

RECOGNITION (Figure-3.I(c))—or being adequately rewarded and appreciated for one's efforts or talents [16]—was also mentioned by our participants. P13, for example, defined success as "*being recognized by the community and the project's stakeholders*." P1 considered recognition as awareness that "the maintainer of these projects know that they can come to [participate] as a subject matter expert" (P1).

#### 4.1.2 Quad2: Interpersonal × Achievement

As per Dries et al. [16], this quadrant includes accomplishments external to the actor's "self"; and contains three distinct regions: Advancement, Performance, and Factual Contribution.

ADVANCEMENT (Figure-3.II(a)) is defined as progressing and growing in terms of level and experience. In the OSS context, this relates to *influencing decisions* about the product, being [part of] an "*influential community that is well recognized*" (P21), *receiving job offers*, "*writing the[ir] own ticket*" in their career (P12), receiving a *salary increase*, or *achieving a top-level position*. "Money", in some cases, was mentioned as representing growth (e.g., "*salary going up*" (P16)), which differs from some other cases in which money represented a way of earning a living from OSS, which we classify as SECURITY.

The PERFORMANCE (Figure 3.II(b)) region is defined as attaining verifiable results and meeting set goals [16]. In our context, this translated to having a *plan for project releases* "depending on what the goals of the project are, such as working on a new release every six months" (P4). Project planning activities show the relation of the actor to the external world (interpersonal dimension), as explained by P4: "if [one is] not making [the release], [they are] letting a lot of people down".

FACTUAL CONTRIBUTION (Figure-3.II(c)) is about individually contributing to the collective [16]. An indication of success in this region includes *bringing contributions to an OSS project*, by "*getting a change that you wrote, accepted*" (P12), including "*a code change, a documentation change... [or otherwise] getting something you made merged*" (P12). Besides code contributions, interviewees mentioned other factual contributions pertaining to implementing ideas, changes, or any type of revisions or contributions to the project, as well as "*actively reviewing and looking at what*

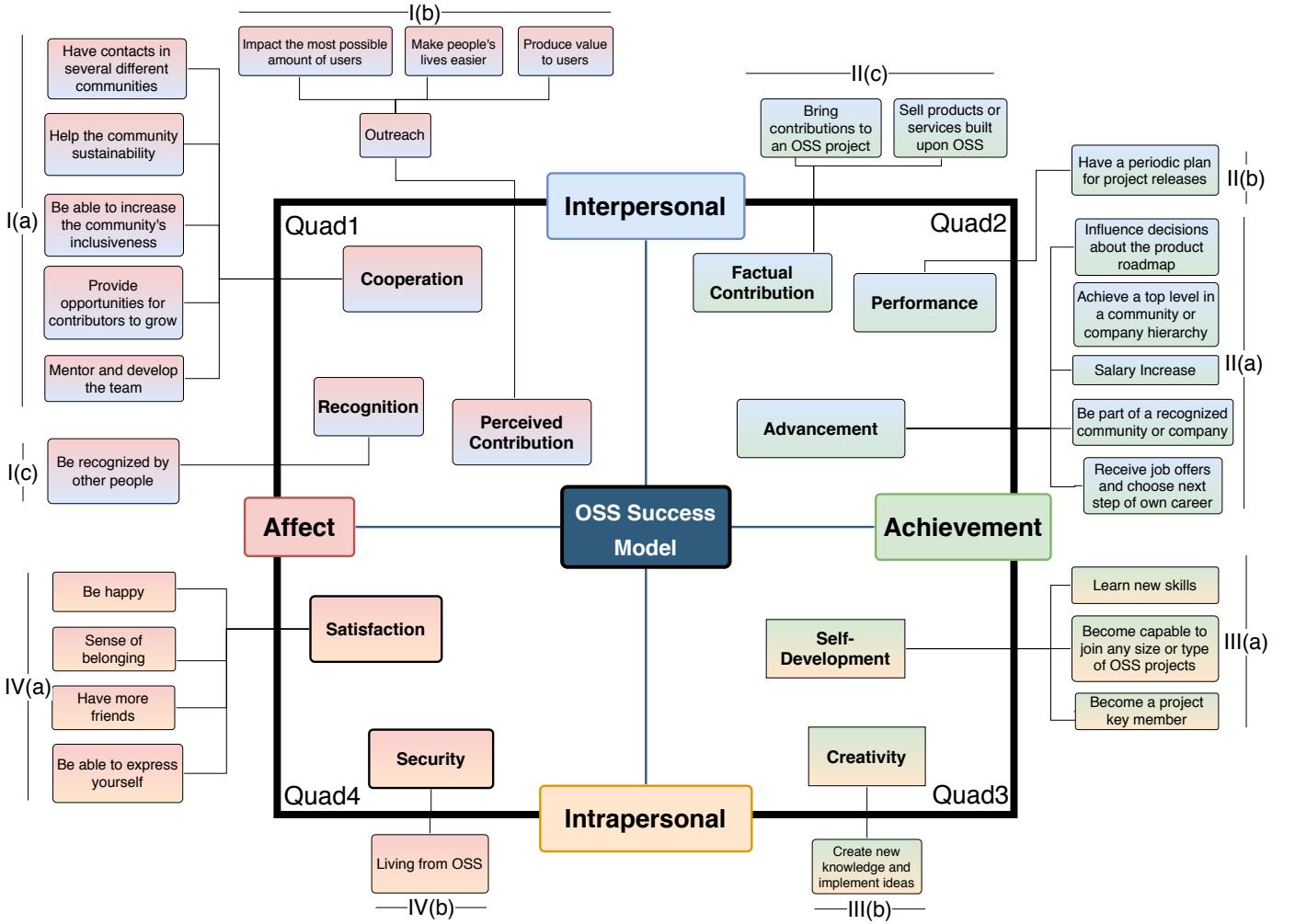


Fig. 3. OSS Success Model. We mapped our participants' definitions (shown outside the bold square) to Dries et al.'s model [16], which organizes success in four quadrants.

people are suggesting" (P2). Contributions can also represent something tangible, as having financial gains when "selling the platform" (P6) or when having a "ventured organization" (P6).

#### 4.1.3 Quad4: Intrapersonal × Affect

Dries et al. [16] describe this quadrant as including real accomplishments of the actor's "self". It contains two distinct regions of meaning: Self-Development and Creativity.

SELF-DEVELOPMENT (Figure-3.III(a)) is defined as realizing one's potential through self-management of challenges and learning experiences [16]. This has been a classical motivation for contributing to OSS [8, 9, 34]. However, success definitions cited by our participants go beyond "learning new skills" (P16). They also include serving as a *key project member* by "being a mature reviewer and contributor" (P2) "capable of effecting change in an open source project, from the small to the large" (P7).

CREATIVITY (Figure-3.III(b)) is about making something innovative and extraordinary [16]. We found this to mean the freedom to "create new knowledge" (P3), but also as the possibility of "propagating ideas" (P3). Creativity is relevant to the OSS context as individuals from creative communi-

ties have greater opportunities to express themselves and experience a sense of accomplishment [34].

#### 4.1.4 Quad4: Intrapersonal × Affect

The Intrapersonal × Affect quadrant includes feelings and perceptions that characterize the career of an actor's "self" [16], which contains two regions: Satisfaction and Security.

SATISFACTION (Figure-3.IV(a)) is about achieving happiness and personal satisfaction, either in the family or in the work domain [16]. Participants mentioned satisfaction as "being happy" (P1, P16, P26), which also included "being able to express yourself" (P10). They talked about their *sense of belonging* and "need for emotional inclusion" (P16), "participating in the world that is being created" (P10), and having "a ton of friends and people [who they] would hang out with or chat with, about non technical stuff" (P5).

SECURITY (Figure-3.IV(b)) means meeting one's financial or employment needs [16]. Participants mentioned success as being able to *make a living from OSS*—to "receive money as an OSS developer" (P24) and "prioritize what [financially] sustains you" (P19).

TABLE 4  
Success meanings from the interviews and the survey classified per Dries et al.'s model [16]

Region	Participants' IDs (Interviews)	# Interviews (total: 27)	# Survey (total: 193)
Quad1	Participants who mentioned at least one Region in Inter-personal	26	162 (84%)
	Cooperation P2, P3, P4, P5, P7, P8, P13, P15, P17, P20, P21	11	19 (8%)
	Perceived Contribution P5, P6, P9, P11, P17, P18, P21, P22, P25	9	57 (30%)
	Recognition P1, P9, P13, P22, P23, P25	6	29 (12%)
Participants who mentioned at least one Region in Q1		<b>19</b>	<b>93 (48%)</b>
Quad2	Advancement P1, P10, P12, P16, P20, P21, P22, P23, P24	8	8 (4%)
	Performance P4	1	0 (0%)
	Factual Contribution P2, P6, P12, P14, P18, P19, P20, P21	8	74 (38%)
Participants who mentioned at least one Region in Q2		<b>15</b>	<b>81 (42%)</b>
Participants who mentioned at least one Region in Intra-personal		11	49 (25%)
Quad3	Self-Development P7, P16, P18, P19, P20, P21, P24	7	19 (8%)
	Creativity P10	1	2 (1%)
Participants who mentioned at least one Region in Q3		<b>8</b>	<b>21 (11%)</b>
Quad4	Satisfaction P1, P5, P10, P16, P21	5	13 (5%)
	Security P19, P24	2	17 (7%)
Participants who mentioned at least one Region in Q4		<b>7</b>	<b>30 (16%)</b>

**Quad1:** Interpersonal x Affect; **Quad2:** Interpersonal x Achievement; **Quad3:** Intrapersonal x Achievement; **Quad4:** Intrapersonal x Affect  
The total per quadrant is not the sum of the regions since the participants often provided an answer that was categorized into **more than one region**.

Success is a multifaceted and complex concept, including both objective metrics and subjective perceptions of accomplishments. Despite its vastly different philosophy of contribution, OSS can provide similar avenues for success as described by Dries et al.'s model.

## 4.2 Survey analysis

As explained in Section 3.2, we conducted a survey to triangulate the definitions of success we identified from the interviews, expanding our population and checking if we could find any new definition of success. We qualitatively analyzed the 193 answers to our survey open question. Similar to interviews, the participants often provided multiple definitions, which could be categorized into more than one region from Dries' model [16].

The survey analysis did not reveal any new categories. Thus, the 26 codes from our *interviews were sufficient to encompass the definition of success from the survey respondents*.

In this section, we look deeper into the survey results to understand the prevailing definitions of success among our respondents and across different demographics. When presenting the results, we use supplementary and corroborative counting of the survey responses to triangulate qualitative analysis of the definitions of success [35].

**The dimensions of success.** The majority of respondents defined success as the relationships with the external world (Interpersonal) rather than within the actor's self (Intrapersonal), accounting for 84% vs. 25% of respondents. For the Interpersonal dimension, respondents identified success across both ends of the Affect and Achievement spectrum—25% were related to the Affect dimension and 49% were related to Achievement. When considering definitions related to Intrapersonal, none of the regions were mentioned by more than 10% of the respondents. This preponderance of definitions related to the Interpersonal side could be because of the collaborative nature of peer-production sites such as OSS, where contributing to a common good and

being recognized for it have been cited as key motivation factors [8, 9, 10, 36, 37].

In fact, FACTUAL (38%) and PERCEIVED CONTRIBUTION (30%) were the most mentioned regions, followed by RECOGNITION (12%). None of the other regions across all quadrants had more than 10% responses. These responses reflect that in OSS, while making contributions matters, the way that others (community, peers, society) value the contributions is also an important indicator of success.

Respondents who identified FACTUAL CONTRIBUTION as a definition of success emphasized that the number, size, and frequency of contributions can be objective concepts to quantify a significant contribution to the community. They defined success as "*finding a way to sustainably contribute*" (S25), or being "*someone who is able to regularly contribute*" (S11) and "*spending time on the project often*" (S68). By doing so, a successful contributor is the one who provides "*a wide spectrum contributions*" (S6). Moreover, respondents identified different types of contributions for contributors in different project-centric or community-centric roles [1], as mentioned by S2: "*Successful contributors add or change major features, and organize the community*".

Those who considered PERCEIVED CONTRIBUTION as their meaning of success emphasized the importance of their contribution such as, publishing and maintaining software that is used by and useful to a lot of people. According to S136, the perceived value of their contribution could be measured by "*how many people have used the OSS code and how much value has it created*". Some of these definitions of success in OSS included: "*someone who publishes and maintains software that is useful for a lot of people or for the user community*" (S3) and "*when the software solves and helps real world problems*" (S169).

Finally, our respondents reflected many different perceptions of success related to RECOGNITION in their community; which included "*having a high number of stars on the own repository in GitHub*" (S58 and S109), "*receiving donations*" (S21), and "*being invited for conference invites/talks*" (S16).

**Demographics and the meaning of success** As recent

literature has shown, the OSS community is becoming more diverse in terms of the gender of contributors, types of contributions, and financial rewards [1, 12]. We took a deeper look into these demographic subgroups with respect to their definitions of success. Understanding how different demographics perceive success can help us create mechanisms to better support diverse demographics, thereby helping improve the state of diversity in OSS. Figure 4 illustrate the definition of success by each demographic subgroup.

From the 193 survey respondents, 165 identified as men, 16 as women, and 2 as non-binary. The gender distribution of our respondents matches that of those reported in other OSS studies ([38, 39, 40]). We dropped from this analysis the 10 respondents who did not disclose their gender. Comparing the distributions of definitions reported by men and women, we could not find statistically significant differences between the two groups neither in terms of quadrants, nor in terms of regions. As illustrated in Figure 4, both men and women more frequently mentioned success definitions classified in the Interpersonal quadrants (Quad1/Quad2) than those in Intrapersonal (Quad3/Quad4).

Our survey included answers from 163 *coders* and 30 *non-coders*, i.e., those who work only on non-code related activities (e.g., advocacy, license management, technical writing). We could not find statistically significant differences between the distribution of answers from the two subgroups. We could also not find statistically significant differences when sub-grouping based on compensation (paid vs. unpaid). The statistical test results including the p-values of these comparisons are in the supplementary material.

The Interpersonal dimension plays a dominant role in the definition of success, in which factual and perceived contributions are the most referenced, followed by recognition. Contributors across different demographic groups—gender, contribution type (code vs non-code), and compensation (paid vs. non-paid)—report similar perception of success.

## 5 DISCUSSION

### 5.1 Success is multifaceted and hard to measure

Success in OSS is a complex concept with multiple dimensions. Our participants reported different definitions for success, encompassing all the regions of the Dries et al.’s model [16]. Even a single person’s understanding can span multiple dimensions. Therefore, the current view of successful OSS contributors being code “hackers” [34] is inadequate, even from the point of view of coders. Success in OSS is a nuanced, multifaceted concept that goes well beyond becoming a core member or a maintainer.

This variety of perspectives makes it challenging to measure success. Even common terms, such as “contribution,” can be understood from different perspectives. While some people consider achieving a high number of contributions or becoming a frequent contributor as a measure of success, others relate success to the impact of their contribution—or how it is perceived by their users, community, or society. Current literature, tools, and project infrastructures,

unfortunately, tend to focus on the measurement of code-centric contributions (e.g., [37, 41, 42]). However, there are subjective perspectives of success closer to the *Affect* dimension that also need to be measured. For example, how does one measure contributions for those who mentor or work to make their communities inclusive (Quad1). The benefits of these types of contributions are intangible and by its very nature difficult to measure. In fact, our results show even tangible products, such as money, can itself represent multiple meanings of success; SECURITY when related to making a living from OSS, and ADVANCEMENT, when related to career growth (salary increase). Therefore, it is important that researchers and practitioners take a more nuanced approach in developing ways to evaluate success, considering the multitude of profiles and activities that are now part of OSS. There is no “one size fits all” measure of success.

### 5.2 Coders & non-coders look for the same pot of gold

While coders and non-coders may contribute differently to OSS, they perceive success in similar ways. Our analyses (Figure 4) show that both coders and non-coders often mentioned definitions that relate to the *Interpersonal* dimension.

Despite this commonality in the definitions of success between coders and non-coders, prior research has shown that they perform different roles and have different career pathways in OSS [1, 12]. These pathways may include not only code-centric, but also community-centric activities, including advocacy, community building, mentorship, and technical writing. These activities are important for projects’ sustainability and growth, but are currently not well-recognized.

Therefore, showing individuals that there are multiple ways to achieve success is important, regardless of their roles. To do so, current strategies and metrics to support contributors need to be adapted to consider the multitude of success definitions not only for code-related activities, but also for activities not directly related to code. For example, coders gain recognition from having their names in a “credits” file or badges in their profiles, but non-coders are commonly overlooked because their activities are harder to quantify [43]. Identifying ways of showing RECOGNITION for non-coders is important too, not only to help them get “credit” for their work, but also to reflect their expertise.

### 5.3 Subjective definitions of success is prevalent

In our study, both men and women mentioned success definitions related to the *Affect* and *Achievement* dimensions at similar rates. Contrary to research in other domains [15, 44, 45] which found that men relate success to tangible and objective outcomes, the men in our study often provided meanings of success related to the subjective side.

We hypothesize that the nature of OSS defines how people see success in this context. OSS is an open collaboration community [46], in which collective work is central to the success of projects. Additionally, altruism, reciprocity (giving back), and maintaining high-quality social bonds are common motivations to contribute to OSS [10, 36]. These motivations relate to working together to create better software and for the greater good. Therefore, individuals

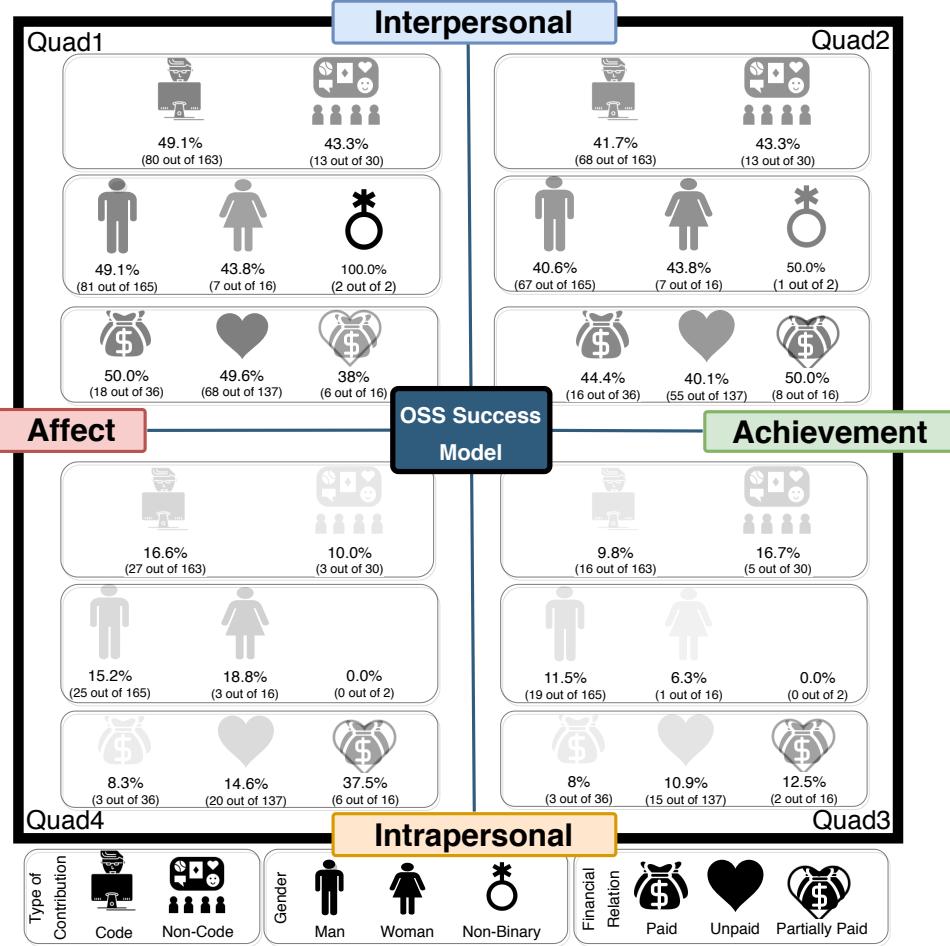


Fig. 4. Subgroup analysis of the meanings of success. The icons' opacity represent the percentage of each group for the quadrant. Darker means higher and lighter means lower percentage. Some respondents provided answers about success that accounted for more than one quadrant.

who are attracted to an open-collaboration community may attribute a high value to these dimensions.

#### 5.4 Implications

In addition to the implications mentioned as part of the discussion, we highlight another set of ways that our results may inspire researchers and communities.

The definition of success presented here can help OSS communities and organizations better support contributors on achieving the success for which they aim [47]. By understanding how contributors perceive success (and what they seek), leaders can cultivate practices that highlight the success attributes within their teams. This may guide OSS projects that face a high turnover rate in designing retention initiatives.

For novice professionals and those joining their career in software development, the results show that OSS offers different “pots of gold.” By shedding light on what success means in OSS, we may show that OSS is attractive and that it is possible for them to achieve their long-term goals.

Individuals with diverse backgrounds and definitions of success may need different engagement strategies. By recognizing that success is multifaceted and multiple success definitions apply to OSS, communities can leverage

our (sub-)categories to support the growth of individuals with different success definitions. For example, one strategy that communities employ is organize meetups with different communities to increase contributors’ social capital; “Having contacts in several different communities”( Fig.3 I(a)) was frequently mentioned as a success factor). Another strategy could employing different recognition programs that value different types of contributions [1], aiming at those who perceive success as “being recognized”(Fig.3 I(c)).

The multitude and nuances in the definitions of success can serve as input to different research topics that have been investigated in the context of OSS. It is important to find ways to support the growth of people whose background is not related to software development. Their activities are harder to quantify, given that they usually do not leave traces on project repositories. Thus, this may pose challenges that go beyond just proposing metrics, and toward proposing changes on how these activities are performed, logged, and weighted. This may have additional impact on topics like mining and creating virtual resumes for hiring purposes [48], recommending mentors [49], and providing paths to becoming central to the project [6, 50].

## 6 RELATED WORK

We could not find any software engineering research investigating the meaning of success for OSS contributors, but there are several studies about being a “great” software engineer and a “great” manager. Li et.al [51] conducted a study to reveal the characteristics that distinguish “great” software engineers. Authors found that the top five characteristics are writing good code, regulating behaviors to account for future value and costs, exercising informed decision-making, avoiding making colleagues’ work harder, and constantly learning. Kalliamvakou et. al [52] investigated the attributes of a “great” manager. According to their study, some level of technical skills is necessary, but not as relevant as management skills to guide engineers to make decisions, to motivate them, and to mediate their presence in the organization. The focus of both studies is not on what means to be a successful software engineer or manager—“greatness”—, but the competences and skills to be “great.”

Kimmelmann [47] investigated the technical, social, and personal competencies developers need according to their stage in OSS projects. The author argues that these competences can support or hinder a successful career by regulating professional behavior. The author investigated the competences and skills needed to advance in an OSS career, but not what it means to be successful.

Some researchers investigated success from the point of view of the OSS projects. Crowston et al. [53] analyzed how to assess the success of OSS projects, based on a literature review and the opinion of SlashDot OSS developers. Subramaniam et al. [54] also assessed the success of OSS projects by using longitudinal data on OSS projects and examining the relationship between OSS project success and OSS project characteristics. Midha et al. [55] selected two measures of OSS project success, project popularity and developer activity, to apply and investigate over 283 OSS projects over time. Sen et al. [56] also presented a study about the definition and metrics to evaluate the success of OSS projects.

Some research considers core developers as “elite contributors” [7] or code heroes [6], who receive commit rights based on trust [57]. Although code heroes are valuable for OSS projects [6], being a core developer is not the only way to be successful. According to Zhou and Mockus [50], newcomers stay longer and become Long Term Contributors (LTC) if they start with comments and demonstrate a highly community-oriented attitude. While the theoretical converging lens orients most OSS research efforts towards the project-centric and technical side of OSS project development, our study aims to unveil other perspectives of success beyond the traditional ways to measure success of OSS contributor.

Finally, success perceptions and motivation behind contributing to OSS are interrelated, complement each other, and can play different roles. Past work has studied what motivates people to contribute to OSS (e.g., [9, 10, 36]). However, when considering the comprehensive motivation model by Von Krogh et al. [10], some motivation factors do not map to our model (e.g., “Own-use”) while some of our success definitions do not map to motivation factors (e.g., “Have a plan for project releases (Performance)”). On the

other hand, there is an intersection between definitions of success and motivation factors. For example, money, ideology, and reputation can be found both in the OSS motivation literature [10] and in our model of success perceptions. Our results can be used in future work to investigate how OSS contributors with different motivations perceive success.

## 7 LIMITATIONS

**Internal validity.** The characteristics of our sample may have influenced our results. A great part of our interviewees (11 out of 27) were speakers at an OSS conference and half (13 out of 27) of the interviewee identified as women, even though we did not push toward having an equal gender split. This diversity of profiles helped bring a more diverse perspective about the phenomenon. Our survey, which received almost 200 answers, corroborated our results. The distribution of our survey demographics is similar to the larger OSS population as reported elsewhere [38, 39, 58, 59].

**Construct validity.** The main threat to construct validity in this work relates to the question about success, which explicitly asks how the respondent defines a successful person in OSS. While the question refers to the individual’s perspective, respondents could interpret the question differently and answer from the perspective of a typical contributor. This was not a problem for the interviews, since we would have been able to clarify the question (none of the interviewees misinterpreted this question). We believe this threat to be minimal in the survey too based on our pilot studies. Moreover, individuals’ perceptions about typical and prominent participants in the OSS ecosystem are also relevant in creating a broad understanding of success.

**Survival bias.** Our results reflect the opinion of current contributors, who joined OSS and made it past the initial contribution barriers [60]. Therefore, to promote diversity in OSS, we acknowledge that additional research is necessary to understand success from the perspective of those who do not make it past the initial barriers and those who are currently not attracted to OSS.

**Recall bias.** Moreover, as our survey question was open ended, our results could be impacted by either salience bias, where respondents focus on definitions that are prominent or emotionally striking and not necessarily all the factors that matter; or by memory bias, where participants answered questions based on what they can first recall and not necessarily what’s most important to them.

**Data Consistency.** Consistency refers to ensuring that the results consistently follow from the data and there is no inference that cannot be supported after the data analysis [61]. To increase consistency, we performed data analysis in a group of three researchers. We had weekly meetings to discuss and adjust codes and categories until we reached agreement. In the meetings, we also checked the consistency of our interpretations, continually discussing our results based on definitions of Dries et al.’s model [16]. All analysis was thoroughly grounded in the data collected and exhaustively discussed amongst the whole team to reach an agreement. The team includes researchers with extensive experience in qualitative methods.

**Theoretical saturation.** A potential limitation in qualitative studies regards reaching theoretical saturation. In this

study, we interviewed 27 participants with different backgrounds and perceptions about the studied phenomenon. The participants are diverse in terms of gender, number of years involved with OSS, and highest achieved academic degree. We kept inviting participants until we could not find any new concept for five consecutive interviews. Moreover, we collected answers from 193 respondents about what it means to be a successful OSS contributor, and we could not find any new meanings. Therefore, although theoretical saturation cannot be claimed, we believe that we obtained a consistent and comprehensive account of the phenomenon.

## 8 CONCLUSION

In this paper, we investigate how OSS contributors define success. OSS has considerably changed over the last 20 years, from a generation of code-oriented volunteers to an ecosystem in which industry consortia push OSS projects forward with a significant amount of professional and paid contributors [62]. Our results show that OSS contributors have a broader perspective on success than the narrow focus on code-related activities—which is better supported by current tools and practices.

Our study of 27 interviews with well-recognized OSS contributors and a follow-up survey of 193 OSS contributors reveal a multi-faceted definition of success. We found 26 categories of definitions through our interviews and framed them through the theoretical lens of an existing success model by Dries et al. [16].

Our analysis shows that success is a multi-faceted complex concept, including both objective and subjective accomplishments. Even tangible items such as “money” can mean different things to different people (e.g., a way to advance in career or a way to secure a living). Despite its vastly different philosophy of contribution, OSS actually provides similar avenues for success as in more traditional career models. A key difference from other traditional models however was the predominance of success definitions in the interpersonal dimension. This was common across all respondents irrespective of gender, role, or employment status in OSS.

In conclusion, we hope our work in revealing the nuanced definitions of success that OSS contributors have can help us find out how to support diverse individuals with diverse backgrounds. Let us work together to support the different contribution pathways to help individuals reach that elusive pot of gold at the end of the rainbow.

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