Knights and Gold Stars

A Tale of InnerSource Incentivization

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// We describe a comprehensive InnerSource incentivization program implemented at Huawei that has had impressive early results, leading to significant increases in the number of InnerSource projects, participants, departments, and lines of code cont. //

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OVER THE PAST 25 years, the open source software (OSS) phenomenon has arguably been the greatest disruptive force in the software field, demonstrating that high-quality software can be produced by a globally distributed and largely volunteer workforce, certainly countering early skepticism about the future of OSS.[1] This has had major implications in both research and practice, and organizations around the globe are incorporating open source (OS) practices into the way they build and ship their own software. This software development approach, commonly known as "InnerSource," focuses on leveraging the OS development model for creating proprietary software. The popularity of InnerSource has increased dramatically over the past few years, with many organizations, including major technology companies, such as Microsoft, Huawei, Tencent, and PayPal, and even non-IT companies, such as Bloomberg, Bosch, and Nike, embracing the culture. InnerSource Commons, an online community of InnerSource practitioners, has over 1,300 subscribers across 500 organizations.[2]

A number of significant benefits may arise from successful implementation of InnerSource.[3,4] These include the following:

- *Increased code reuse*: Sharing code and collaborative development across organizational divisions ensures increased code reuse.
- *Quality improvement*: More reviews of requirements and code, testing facilitates, and bug discovery (by leveraging Linus's law: "Given enough eyeballs, all bugs are shallow") improves the overall quality of the software product.
- *Open innovation*: Access to broad and deep knowledge beyond the confines of the department originally developing the software facilitates open innovation.
- *Improved staff mobility*: Greater familiarity with development and interaction with colleagues outside departmental silos facilitates staff mobility across divisions.

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- *Attracting and recruiting talented employees*: Most fresh graduates are familiar with the OS model and expect and are attracted to a development environment conducive to social coding rather than a tightly controlled, traditional one.

However, the successful implementation of InnerSource has long been a challenge,[5,6] and significant institutional change may be required.[7] A number of barriers can arise in organizations and hinder InnerSource implementation, as identified by the "2020 State of InnerSource Survey."[8] These include the following:

- *Time constraints*: Developers in organizations are fully committed to their "day job" and often do not have the capacity to take on additional development tasks for InnerSource.
- *Lack of recognition*: Traditional performance appraisal mechanisms are typically designed for silos of organizational departments and divisions and often do not recognize the panorganizational nature of InnerSource. Moreover, developed code is not viewed externally, so there is limited visibility of InnerSource contributions outside the company, which doesn't help an individual's career as much as OSS contributions.
- *Lack of community support*: The "free rider" phenomenon, whereby individuals take more than they contribute, which has been reported for OS, applies to InnerSource. Contributors to InnerSource might want to grow through participation, but without the support of an active and supportive community, they might end up working on maintenance issues against their will, and they might experience frustration and burnout in the process.
- *Lack of management support*: Lower and middle management often focus more on short-term targets, prioritizing local development activities over InnerSource work since there is no immediate benefit to their divisions.
- *Liability to fix code*: Developers may fear that contributing code to InnerSource will require them to maintain that code indefinitely and be responsible for any issues that arise through the use of the code.
- *Fear of contributions being "hijacked" without due credit*: Somewhat in opposition to the previous concern, developers may fear that others will take credit for their InnerSource contributions.

To successfully implement InnerSource at an organization and realize its benefits, it is essential to address the barriers to InnerSource adoption. This can be achieved through appropriate incentivization.[9] However, designing a suitable incentive program for facilitating InnerSource adoption is not trivial. InnerSource lies at the intersection of OS and closed source development; thus, the motivations for those involved are not exactly the same as either in isolation.[10] Moreover, to the best of our knowledge, there is no existing research on a structured incentive program tailored to facilitate InnerSource adoption. In this article, we address this gap by presenting the InnerSource implementation at Huawei and the structured incentive program proposed for facilitating its adoption.

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Motivations for OS Participation

While InnerSource and OS share many similarities, they also differ on a number of dimensions, including the nature of the workforce and the locus of control.[10] We are not aware of research on an incentive program designed specifically for InnerSource. However, a lot of research has focused on the motivations underpinning OSS participation more generally. These include the following broad categories:[11]

- intrinsic motivators (e.g., ideology, kinship, and enjoyment and fun)
- extrinsic motivators (e.g., pay and career)

- internalized extrinsic (e.g., reputation, learning, reciprocity, and own use).

We briefly elaborate on each of these categories. Intrinsic motivation has long been identified as a key factor in OS. Ideology was at the heart of the free software movement that predated OS. Closely related to this is the concept of kinship. Helping a group to which OS developers feel a tie of kinship is thus a strong motivator. Also, the idea of enjoyment and fun is intrinsically motivating and has been identified as a core aspect of the "hacker culture" in the 1980s that also fueled the emergence of OS.

Extrinsic motivation, such as pay and career, has become a major factor in OS, especially over the past few years. As more companies become involved in OS and as it becomes a key strategic component in the software industry, the model whereby developers are paid to work on OS becomes increasingly common.[12] Also, OS contributions could be clearly attributed to individual developers, and hence, these could form part of a developer's achievement that could support career progression, employment, and promotion.

Some motivators, which might appear, at first glance, to be extrinsic, can also be internalized by developers to the extent that they act as self-regulating behavior. For example, reputation is a major factor underpinning developer involvement in OS, especially among peers. Learning is also a significant motivator, in that developers can improve their skills through the transparency of contributions that address technical challenges. Reciprocity belongs in this internalized extrinsic category, considering that developers are happy to contribute according to their strengths and expect their contributions to be reciprocated by others. Own use value follows from this, as developers seek to consume OS products for their personal use.

InnerSource Adoption at Huawei

Huawei is a multinational technology corporation headquartered in Shenzhen, China. It designs, develops, and sells telecommunications equipment, consumer electronics, and various smart devices. Huawei has almost 200,000 employees and deployed its products and services in more than 170 countries. It was ranked the second-largest R&D investor in the world by the European Union Joint Research Center in 2021.

Due to its size, there is a lot of human potential in Huawei that is hard to fully utilize in a traditional governance system. Therefore, Huawei decided to adopt InnerSource to promote panorganizational knowledge sharing and open innovation. There are four key mechanisms supporting the InnerSource adoption at Huawei, that is, the governance mechanism, infrastructure support, promotion and training, and the structured incentive program for InnerSource contributors. We briefly review the first three mechanisms to provide some context before we discuss the incentive program in detail in the following sections.

InnerSource Governance

To oversee the task of InnerSource adoption, Huawei established a very high-level InnerSource Foundation across the entire organization. This is chaired by a Huawei fellow, and its members include the president of each product line and the director of each R&D department. The mandate of this foundation is to approve Huawei's InnerSource policies, charters, mechanisms, and plans. The foundation is also charged with promoting the InnerSource concept throughout the organization and building a healthy InnerSource ecosystem, culture, and climate.

This InnerSource Foundation is further underpinned by an InnerSource technical committee (TC) chaired by a Huawei Fellow and including the chief software engineers of each product line. The TC is the primary one coordinating InnerSource activities at Huawei. The remit of the TC is as follows:

1. select and establish the appropriate InnerSource technology communities and projects, based on the overall strategy and direction of the board of directors
2. define the phases (preparation, incubation, and graduation) and requirements of InnerSource projects, review and approve InnerSource communities and projects, and guide the operation of each InnerSource project
3. develop, maintain, and publish the Huawei InnerSource license and arbitrate technical disputes arising from noncompliance with InnerSource use
4. promote and spread the culture of InnerSource and motivate and recognize InnerSource technology communities, projects, and individuals that have made outstanding contributions.

In addition to the TC, there are technical community committees (TCCs) that are specific to each product line and oversee InnerSource activities and facilitate communications among members of different product lines. The TCCs review and approve InnerSource communities and projects; appoint project management committees (PMCs) for InnerSource projects; identify InnerSource opportunities in the technology domain; build a healthy

and vibrant InnerSource technology ecosystem; evangelize the InnerSource culture; motivate and commend outstanding InnerSource technology communities, projects, and individuals; and publicize InnerSource concepts to other departments.

The PMC is the technical management committee for each InnerSource project, consisting of project maintainer representatives and other stakeholders, including management. PMCs are tasked with ensuring the following three key requirements:

1. An InnerSource project is consistent with the strategy and values of the department.
2. Credit for contributions to the InnerSource project is correctly given, and contributions do not result in an unreasonable demand for subsequent maintenance.
3. Contributors have autonomy and can focus on building their reputation and influence through InnerSource.

InnerSource Infrastructure

Infrastructure support is a necessary component for successful InnerSource implementation.[13,14] A team of engineers at Huawei helps in the design and implementation of required components, e.g., an InnerSource portal and dashboard showcasing the active projects and individual profiles of InnerSource contributors, their activity, and badges/awards. It also helps track the activity of projects and developers, using various metrics as required by the wider community of InnerSource participants in the organization.

InnerSource Promotion and Training

Since InnerSource operates quite differently from traditional development operations at Huawei, having standard procedures is key for ensuring that the InnerSource community can thrive. The two main goals for setting up the processes are spreading awareness about InnerSource within the company to help attract new developers via various online and offline promotional activities, such as meet-and-greet sessions, hackathons, and new developer meets, and, second, ensuring the smooth operation of existing InnerSource projects, e.g, asynchronous and collaborative development, meritocracy, and so on, by providing training to InnerSource participants. The processes are overseen by the InnerSource governing bodies at different levels, which design and promote InnerSource standards and practices, ensure that the rules are followed, and act as arbiters in case of any disputes.

Designing an InnerSource Incentive Program at Huawei

To facilitate the adoption of InnerSource and recognize employee contributions to InnerSource projects, Huawei designed and implemented a structured incentive program, which is a complement to the company's employee appraisal system, as discussed in the following. In designing the InnerSource incentive program, a number of fundamental concepts underpinning motivation were drawn on. These include Maslow's proposed hierarchy of needs, from physiological and safety needs to those of esteem and self-actualization. In a similar vein, Herzberg's two-factor theory[15] identifies hygiene factors and motivating factors. Hygiene factors, if not present, will cause an employee to work less and lead to dissatisfaction, while motivating factors will encourage an employee to work harder and can bring about satisfaction. More contemporary thinking on motivation was drawn from Pink's "drive" concept, which identifies three categories of motivation: autonomy, mastery, and purpose.[16]

These concepts were vital in designing the InnerSource incentive program at Huawei. Theories on general motivation were combined with empirical and contextual knowledge, that is, the research findings on OSS developer motivation and research on existing employee appraisal frameworks, as well as the management styles of large OSS communities, such as Linux and the Apache Software Foundation, to come up with a concrete strategy for tackling the barriers to InnerSource adoption and motivating individual developers, potential project maintainers, and management to adopt InnerSource.

Hygiene/Deficiency Factors

Many of the barriers to InnerSource adoption are conceptually similar to the lower levels of Maslow's hierarchy of needs, e.g., physiological and safety needs, and can be thought of as "hygiene" factors: they are necessary precursors to initiate InnerSource adoption but do not actively create an InnerSource culture. These factors include time constraints, lack of support from management and peer groups, fear of not receiving due credit for InnerSource contributions, and having to maintain code indefinitely.

Research suggests that support from top management, colloquially known as "executive air cover," is essential for the effective adoption of InnerSource.[4] For Huawei, the InnerSource Foundation and active PMCs ensure that employees have adequate support from management for undertaking InnerSource work. This also reassures managers at lower levels of the organization, who control the workload of developers in their teams, that there is higher-level managerial support for InnerSource activities.

The regular publicizing of activities, including developer meetups and workshops, educates practitioners about how InnerSource works (since it can be significantly different from the practices followed by individual teams). This, in turn, results in more realistic expectations about InnerSource and helps establish a more supportive environment for InnerSource.

Motivation/Growth Factors

One of the key features of InnerSource is that it is governed by meritocracy and participants' free choice about what to work on and when.[4] The motivations for InnerSource contributors, therefore, are conceptually similar to the higher levels of Maslow's hierarchy of needs, e.g., esteem and self-actualization. In Herzberg's terminology, these are the "motivation" factors and promote growth both at an individual and community level, ensuring the successful adoption of InnerSource and realization of its numerous benefits, as discussed earlier. There are two main types of such factors: extrinsic and intrinsic.

Extrinsic motivation factors are related to the recognition of an individual's efforts, while intrinsic motivations could be categorized as autonomy, mastery, and purpose, using Pink's terminology.[16] By design, Huawei tried to focus less on monetary rewards and more on reputation-based incentives to avoid the "crowding-out effect,"[17] which suggests that offering too much extrinsic (monetary) reward in the context of preexisting intrinsic motivation can sometimes undermine the internal motivation for doing a task, thus decreasing overall performance. We briefly elaborate on these factors in the following.

Recognition. Wanting to be honored and recognized for one's efforts is a basic human instinct, and it could act as a significant motivation. Contributing to InnerSource is an opportunity for individuals to showcase their work to a wider audience and gain recognition beyond their individual divisions. This can act as a huge morale booster. Huawei recognizes its importance, as well, and the incentive program was designed to address this issue.

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Autonomy. At Huawei, the InnerSource working model allows projects to independently determine and control their direction over time. The PMCs have autonomy, e.g., in deciding the project direction, incentives within the project, and project working methods. Moreover, individual contributors are given freedom to choose which projects they want to contribute to and when. This preserves the spontaneity of the InnerSource process and serves to address the need for autonomy.

Mastery. Mastery refers to the desire to constantly improve one's skills, which is seen as a primary goal in itself and not necessarily directly equated with any extrinsic reward. Mastery is also facilitated by autonomy, in that InnerSource contributors are able to choose where and how to contribute. This allows them to choose areas of contribution in which they already have expertise and have a desire to further develop that expertise.

Purpose. As a company that is owned by its employees (through an employee stock ownership program), Huawei recognizes the value of having a sense of loyalty and purpose. Since the InnerSource projects are maintained by the PMCs and contributions are voluntary, developers feel an attachment to a project and strive for its success. This, together with the other motivation factors, gives them a sense of purpose and helps them get closer to achieving self-actualization.

The Proposed Incentive Program

With the theoretical foundation for designing an incentive program in place, Huawei drew on its extensive experience in designing effective employee appraisal systems to create a structured incentive program for InnerSource. The program involves a comprehensive reputation and honor system and a transparent merit-based path for role progression based on an individual's contributions and reputation. There are also special rewards and monetary incentives for exceptional contributors, projects, and divisions, as described in the following.

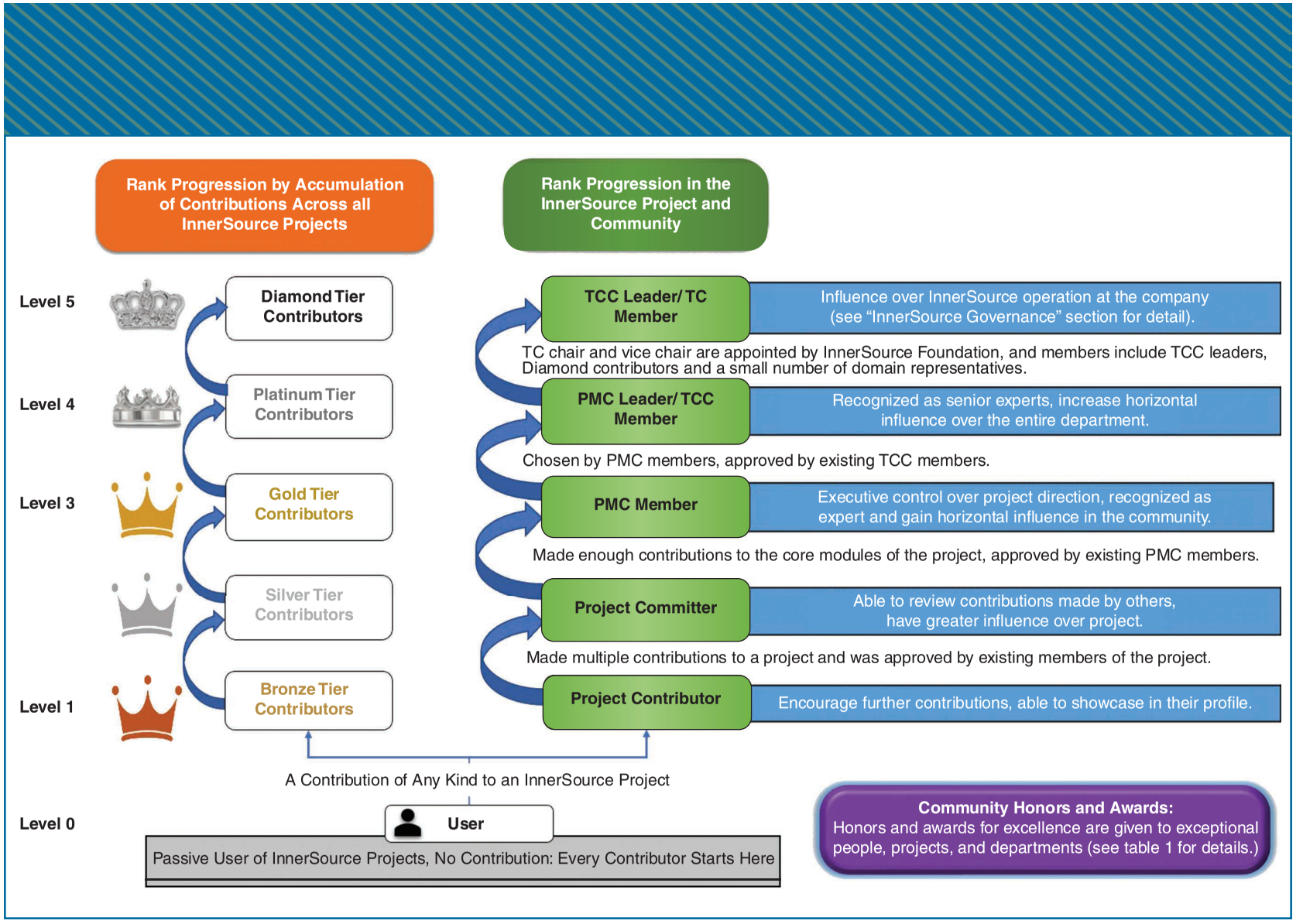

FIGURE 1. The InnerSource role progression at Huawei.

Table 1. The InnerSource honors and awards at Huawei.

Award	Selection criteria	Frequency	Number of awards*	Nonmonetary rewards/ benefits	Percentage of budget
Individual awards					
InnerSource Star Award	This award is given to 1) PMC members/project maintainers who have demonstrated exceptional leadership and generated valuable projects and technical knowledge; 2) exceptional contributors to InnerSource projects who submitted a significant amount of code, reported/fixed bugs, performed code reviews, and undertook mentoring responsibilities; and 3) InnerSource ambassadors who have done an outstanding job promoting InnerSource practices and culture, and attracted new talent.	Monthly	Ten (each receiving 0.25% of overall budget)	Awardees are announced in the "InnerSource" column and promoted in internal newsletters. A star is displayed in their personal profiles, and they are invited to participate in live broadcasts and discussions.	30%
InnerSource Knight Award	This annual award is given to 10 "InnerSource Star" awardees who have brought exceptional value to InnerSource as a whole.	Annual	Ten (each receiving 2.4% of the overall budget)	In addition to the monetary incentive, which is 10 times larger than that given to Star awardees, Knight awardees are given Best Person Memorial Medals, their names are shared in the InnerSource annual report, and they are invited to participate in closed InnerSource workshops to discuss further development plans.	24%
Project-Level Awards					
InnerSource Timely Incentive Award	This award is given to projects that achieved significant results based on the four aspects of the InnerSource maturity model: transparency, collaboration, community, and governance.	Monthly	Five (each project receiving 0.25% of the overall budget)	These projects are granted the "Monthly Active Project" signpost and logo and advertised in corporate-level live broadcasts and workshops.	15%
InnerSource Gold Badge Award	Projects are selected based on excellence for InnerSource activities and community building to achieve business value. The award may be given to several projects, based on a ranking system. Only one project, the best project of the year, is selected for rank 1. Three projects are selected for rank 2, and five are selected for rank 3.	Annual	One best project of the year (5% of overall budget), three runner-up projects (each receiving 4% of the overall budget), and five rank 3 projects (each receiving 1% of the overall budget)	The best project is awarded a crystal medal, and all projects are given customized badges with a "Best Project" logo. Moreover, the product line president and corresponding management team are introduced to the entire company and invited to participate in corporate-level live broadcasts and workshops.	22%

(*Continued*)

Table 1. The InnerSource honors and awards at Huawei. (Continued)

Award	Selection criteria	Frequency	Number of awards*	Nonmonetary rewards/ benefits	Percentage of budget
Departmental Awards					
InnerSource Black Land Award	Special awards for the InnerSource regional operators to create an InnerSource culture in the local research center, generate good InnerSource projects, and encourage more people to participate in InnerSource contributions (by research center region).	Annual	Three (each receiving 3% of the overall budget)	The awardee divisions are given a "InnerSource Black Land Memorial Cup," publicized to the related management levels, and invited to attend closed workshops to discuss further development.	9%

*The monetary reward equates to the percentage of the budget for each awardee.

Contribution-Based Reputation System

Individuals build up their value by making contributions to various InnerSource projects. Two factors were prominent in designing the reputation scheme, as follows:

1. While code contribution to InnerSource projects is counted as the main source of an individual's InnerSource contribution value, other types of contributions, e.g., documentation, bug reports, code review, and technical discussions, are all counted as valid contributions.
2. An individual's contribution value is cumulative in nature, i.e., the contribution points and rewards that are granted never expire. However, an individual's overall standing on the reputation scale may fall if others make more contributions. This takes advantage of individuals' loss aversion instinct since no one wants to lose a position he or she has worked hard to reach, keeping people motivated to continue contributing to InnerSource.

Role Progression

To promote fairness and transparency, Huawei adopted merit-based role progression for InnerSource contributors. Contributors can achieve a rank based on their cumulative contribution across all InnerSource projects and gain a more prominent role in the InnerSource project/community, based on their reputation and subject to approval from the community. The proposed role progression ladder for InnerSource contributors at Huawei is shown in Figure 1. The required number of contributions for rank progression increases exponentially as a contributor's rank increases.

Honors and Awards

As mentioned, Huawei introduced InnerSource Awards that are given to exceptional contributors, projects, and departments. There are monetary as well as nonmonetary incentives associated with each of the awards. By design, these awards are rare and given only in exceptional cases, so the motivation crowding-out effect does not arise. Details of the various rewards are provided in Table 1. It is worth noting that while selecting the awardees, Huawei does not simply look at the total number of contributions. The individual awards, for example, not only recognize those who made significant technical contributions but also those who made important managerial and ambassadorial contributions. As for the projects, they are evaluated on the quality of ancillary resources (e.g., README, documentation, and so on), community management (e.g., issues/public relations handling, transparency in governance, and so on), and their usefulness (e.g., the number of users and the user experience).

Wall of Honor

A hall-of-fame-style "Wall of Honor" is incorporated into Huawei's incentive program to allow more contributions to be recorded and demonstrated over the long term. The homepage of the InnerSource dashboard contains information about active InnerSource projects as well as related information about InnerSource, and it is possible to navigate to the Wall of Honor from the

homepage. The Wall of Honor includes the following:

1. honorary presentations of TCs, TCCs, and project PMCs (with personal information, introductions, and links to personal pages) and diamond and platinum tier contributors
2. annual awards (the InnerSource Knight Award, Gold Badge Project Award, and Black Land Award) and awardees for each year
3. monthly awards (the InnerSource Project Timely Incentive Item and InnerSource Star) and awardees for each month.

In addition, an individual's personal profile page can showcase information regarding his or her contribution records, awards received, and current contributor tier and rank. Through this page, visitors can learn about the technical expertise and interests in InnerSource projects, and they can initiate mutual technical communication.

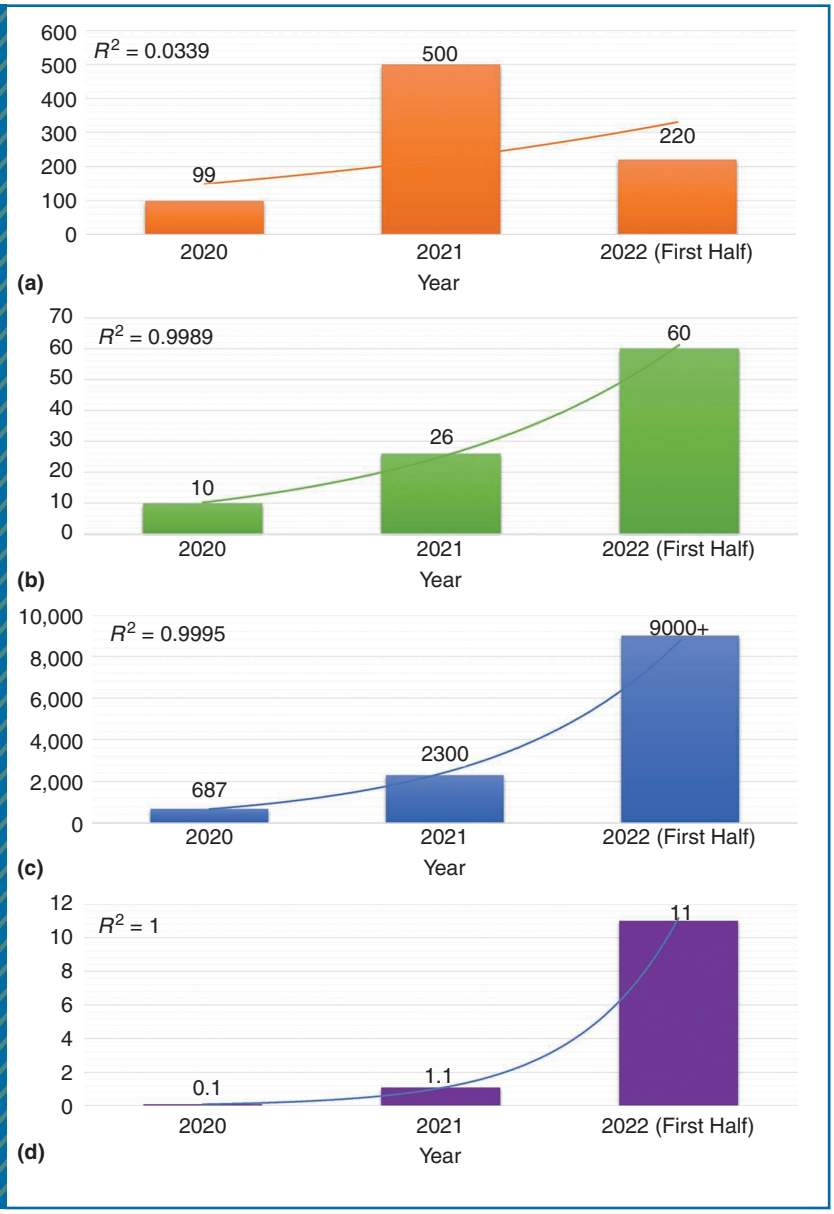

FIGURE 2. The growth of InnerSource at Huawei: (a) number of new InnerSource projects, (b) number of departments, (c) number of contributors, and (d) size of the InnerSource code base, in million lines of code.

Results

The InnerSource implementation at Huawei is still in its early days. The incentivization program was proposed in the second half of 2020 and elaborated and promoted more widely in 2021. As evident from Figure 2, the number of departments involved with InnerSource, number of InnerSource contributors, and size of the code base across all InnerSource projects have increased dramatically since the incentive program was introduced. Although the number of new InnerSource projects in the first half of 2022 is relatively lower, it should be noted that in 2021, a greater proportion of projects began in the second half of the year, and we expect this to repeat in 2022. Moreover, several projects and contributors have been given various awards listed in Table 1, and some contributors have already reached the "gold" tier (see Figure 1).

At present, it is not possible to determine the complete cause and effect of all aspects of the incentive program: it would require a randomized controlled trial, which is very difficult to conduct at this scale. However, given that several Huawei engineers had cited the lack

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of incentives as a barrier when InnerSource was reintroduced in late 2019 and that several expressed a positive attitude toward the proposed incentive program since it was introduced, we are inclined to believe the incentive program has had a positive effect.

Numerous organizations across multiple domains have sought to implement InnerSource. However, implementing InnerSource is extremely complex, and many organizations fail.[3,4] An appropriate incentivization mechanism is key to successful InnerSource implementation. This is no trivial undertaking, as intrinsic and extrinsic motivations need to be incorporated carefully to avoid crowding out and ensure that incentives are appropriate at individual, department, and project levels. The incentive program discussed in this article has been a key mechanism in ensuring the success of InnerSource at Huawei. We believe that this will serve as a good example of how to design an incentive program for InnerSource and be useful to other practitioners in the field.

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