HARVARD | BUSINESS | SCHOOL

Recognition Incentives for Internal Crowdsourcing: A Field Experiment at NASA

Jana Gallus
Olivia S. Jung
Karim R. Lakhani

Working Paper 20-059

Recognition Incentives for Internal Crowdsourcing: A Field Experiment at NASA

Jana Gallus
University of California, Los Angeles

Olivia S. Jung
Harvard Business School

Karim R. Lakhani
Harvard Business School

Working Paper 20-059

Funding for this research was provided in part by Harvard Business School and NASA Open Innovation Research, award #NNX16AC77A.

Recognition Incentives for Internal Crowdsourcing: A Field Experiment at NASA

Jana Gallus
UCLA Anderson School of Management

Olivia S. Jung
Harvard Business School

Karim R. Lakhani
Harvard Business School

Last updated: May 22, 2020

ABSTRACT

What might motivate employees to participate in internal crowdsourcing, a peer-based approach to innovation? Should organizations use incentives that are congruent with their established hierarchical structures, or should they use incentives that are aligned with the aspirational, peer-based approach to innovation? We partnered with NASA for a qualitative study and a field experiment (N=7,455) to understand the effectiveness of different incentives that may motivate its workforce to participate in crowdsourcing. First, we show that concerns about the legitimacy of peer-based innovation disincentivize employees to participate. Second, we find that managerial recognition, the incentive that is congruent with the established hierarchy, significantly increases engagement. It does so by alleviating legitimacy concerns and by offering managerial attention. Peer recognition, which is congruent with the aspirational, peer-based approach to innovation, is not found to have a significant overall effect. However, workers who are otherwise less visible were positively motivated by it. Our research provides guidance for hierarchical organizations that are seeking greater employee engagement in peer-based innovation, and it adds insights on motivational channels to the literature on organizational innovation.

INTRODUCTION

Internal crowdsourcing platforms offer great potential to organizations (Erickson et al. 2012, Malhotra et al. 2017, Malhotra and Majchrzak 2014). Internal crowdsourcing leverages the collective knowledge of the entire workforce inside an organization by broadcasting a problem or question at hand (Jeppesen and Lakhani 2010, Majchrzak and Malhotra 2020). An open call for participation can involve wide swaths of employees in problem identification and problem solving, thus promoting innovation and breaking down functional and geographic silos. Beyond their impact on innovation, such platforms can foster employee engagement and motivation and further improve organizational performance (Jung et al. 2018, Malhotra et al. 2020). Yet despite their promise, adoption of such novel and collective innovation mechanisms can present challenges (Lifshitz-Assaf 2018).

These challenges may be compounded when hierarchical organizations try to adopt crowdsourcing mechanisms *within* their organizational boundaries. Hierarchy is useful for maintaining control and accomplishing routine tasks (Adler 2001, Galbraith 1974, Mintzberg 1971, Zhou 2013). Yet it can inhibit knowledge transfer, experimentation, and ultimately, innovation (Bunderson and Reagans 2011, Teece 1996). Crowdsourcing seeks to "democratize" problem-solving (von Hippel 2005) by relying on an easy, rapid, and transparent flow of information and collaboration among large numbers of people across job functions and geographic boundaries (Guinan et al. 2013, Jeppesen and Lakhani 2010, Lifshitz-Assaf 2018). Hierarchical structures can hamper such free movement of information and instead favor maintenance of the status quo (Teece 1996). Hierarchy is often associated with differential power and status based on position and role (Magee and Galinsky 2008). Those who do not sit at the top of the structural and social hierarchy are less likely, compared to the few that do (Mintzberg 1979), to take initiative or express a creative idea, out of fear that they could lose the respect of peers or approval of higher-status actors (Galinsky et al. 2003, 2008, Nembhard and Edmondson 2006).

We posit that the presence of a marked organizational hierarchy can create important barriers for the successful adoption of internal crowdsourcing processes. Crowdsourcing is likely to feel foreign in an organization that is premised on formalized hierarchical structures (e.g., organizational chart, reporting

protocols) and status based on position and role (Bacharach et al. 1993). Such an environment can create disincentives for employees to engage with crowdsourcing. Consequently, hierarchical organizations may face difficulty motivating employees to engage with internal crowd-based problem identification and problem solution processes. Prior work has not examined whether and how hierarchy can inhibit engagement with internal crowdsourcing. This is an important gap because hierarchy remains a prevalent organizational form (Adler 2001, Mintzberg 1979, Zhou 2013), and it is increasingly supplemented by internal, peer-based crowdsourcing processes (Majchrzak and Malhotra 2020). Any tensions between hierarchy and a peer-based approach to innovation are also likely to influence the effectiveness of different incentives that organizations use to motivate engagement with crowdsourcing.

Recognition incentives are widely used in organizations to motivate people in the knowledge sector (Frey and Gallus 2017). They come in many different forms, ranging from small pins to large statues or the purely symbolic induction into a hall of fame or learned society. Recognition incentives generally draw their motivational value from three dimensions (Gallus et al. 2020a): self-signaling, signaling to others (social signaling), and tangibility (if money or other perks are involved). One important and vastly under-researched dimension that distinguishes the different forms of recognition is the target audience of the social signal. In the context of hierarchical organizations seeking to adopt peer-based crowdsourcing processes, the distinction between recognition in front of management and recognition in front of peers is particularly important. Should such organizations deploy managerial recognition incentives, which fit the established structures, practices, and culture? Or should they focus on peer recognition incentives, which reflect the aspirational, peer-to-peer approach to innovation and signal the intended shift?

We partnered with the U.S. National Aeronautics and Space Administration (NASA), an organization that can be characterized as having markedly hierarchical structures and practices. Prior studies conducted at NASA have noted the layers of decision-making structures, strong norms to adhere to governing structures and communication protocols, and clear professional and departmental boundaries (e.g., Donahue and O'Leary 2012, Hall 2003, Lifshitz-Assaf 2018, Vaughn 1996, 2006). In 2010, NASA

established an organization-wide internal crowdsourcing platform called NASA@WORK. The goals of the platform implementation included encouraging employees to learn about projects and initiatives taking place in other parts of the organization and to break down silos across the agency. However, the platform has been greatly underused since adoption, and our collaboration gave us an opportunity to study the barriers and incentives for platform engagement.

We qualitatively investigated the disincentives that arise from the tension between hierarchy and peer-based crowdsourcing inside the organization. We complemented this qualitative study with a field experiment to study whether and how the two basic forms of recognition, managerial and peer recognition, can mitigate these disincentives and motivate platform engagement. It is difficult to study the causal effects of recognition in the field, let alone test different types of recognition in the same context, holding all else constant. We managed to do so by using a messaging study design that allowed us to exogenously vary the expected audience of recognition: managers or peers. To account for the different peer groups that exist in modern work contexts, we further differentiated between local peers (offline) and peers on the innovation platform (online). To the best of our knowledge, this is the first field experiment on managerial and peer recognition, as well as the first (social science) field experiment conducted at NASA. Combining the experimental approach with qualitative data in a hybrid design allowed us to examine relationships between established constructs like hierarchy and new phenomena like internal crowdsourcing and recognition incentives (Edmondson and McManus 2007).

Our qualitative findings indicate that established hierarchical structures, practices, and culture can give rise to important concerns about the legitimacy of platform engagement, which create disincentives for employees to engage with peer-based forms of innovation. In our organizational context, these legitimacy concerns stemmed from three main factors: workers perceived the crowdsourcing platform to be at odds with the existing, hierarchy-based approach to innovation; they did not consider the platform as a resource for getting their ‘core’ work assignments done; and managerial approval and endorsement for platform engagement were perceived to be lacking. The resulting legitimacy concerns were important for understanding the effects of the recognition incentives we tested in the field experiment.

The field experiment tested two basic forms of recognition incentives, which reflect either the established organizational hierarchy (managerial recognition) or the aspirational, more informal and peer-based approach to innovation (peer recognition). It shows that the prospect of formal recognition in front of management had a significant positive effect: managerial recognition increased the odds of engaging with the platform by 44 percent (p-value=0.005). This effect appears to have operated through two closely-related mechanisms: attention from management, and assurance that management would recognize the positive value of the worker's contributions on the platform. The managerial recognition treatment thus counterbalanced and partly mitigated workers' legitimacy concerns. In contrast, peer recognition was not found to significantly increase platform engagement on average. But as we will discuss, this result masks some interesting heterogeneities by worker type as well as form of peer feedback. Namely, workers who were otherwise less visible (support staff) seemed to have been positively motivated even by smaller, less formal forms of local peer recognition, which the more focal employees disregarded.

Our paper contributes to two bodies of literature: crowdsourcing and recognition incentives. It establishes legitimacy concerns as creating important disincentives for workers in hierarchical organizations to engage in peer-based innovation mechanisms. While several studies have previously analyzed incentives on competitive, outward-facing crowdsourcing platforms, we still have a limited understanding of motivations and incentives for crowdsourcing within organizations. Based on the discourse in the rapidly growing literature on crowdsourcing, which highlights the benefits of decentralizing innovation, one may believe that the most effective way of incentivizing engagement is to leverage peer-based incentives, as opposed to top-down incentives. Our field experiment tests this presumption and links it to the study of recognition incentives. Thus, we also add to the stream of literature on recognition as incentives by advancing our understanding of when and why different forms of recognition work. We study the effects of managerial and peer recognition incentives by exogenously varying the expected audience. This produces the first causal evidence on the motivational effects of these fundamental types of recognition in the same organizational context. We moreover discuss the

mechanisms behind the effects of recognition incentives, and shed light on interesting and important heterogeneities.

The remainder of this paper is structured as follows. We first present relevant literature on hierarchy as a potential barrier to internal crowdsourcing platform engagement and the role that managerial and peer recognition incentives can play to motivate such engagement. We then describe the organizational context and provide details about the innovation platform implemented at NASA. This is followed by an account of the qualitative study setup, analysis, and results. Next, we describe the design of our interventions and field experiment, and then present and discuss the results. We conclude with theoretical and practical implications of our findings, and highlight important avenues for future research.

RELEVANT LITERATURE

Hierarchy as a potential barrier to internal crowdsourcing

Hierarchy is a ubiquitous means of organizing and generally refers to the arrangement of authority (reporting relationships) and roles in an organization (Adler 2001, Mintzberg 1979, Zhou 2013). Hierarchy establishes and formalizes differences among members that translate into a ranking and distribution of resources, control, status, and power (Adler and Borys 1996, Gruenfeld and Tiedens 2010, Magee and Galinsky 2008). It is intended to increase coordination and control of employees (Chandler 1962, March and Simon 1958, Mintzberg 1979) by establishing a social order (Magee and Galinsky 2008), and ensuring that employees pursue the goals decreed by managers (Cardinal 2001).

In practice, hierarchy manifests as layers of sequential authority and formalized work procedures. A hierarchy of authority implies supervisory presence and oversight. Supervisors observe and direct activities of subordinates (Mintzberg 1979). In terms of knowledge flow, they act as gatekeepers who decide whether to pass on any information and proposals from lower levels of the organization up the ladder of hierarchy (Seshadri and Shapira 2003). Members who are lower in the hierarchy internalize and comply with decisions of their superiors, as compliance can help them evade sanction or attain approval

(Gruenfeld and Tiedens 2010, Kelman 2006). In terms of formalized work procedures, written standards codify roles, routines, and workflows (Adler and Borys 1996, Cardinal 2001, Marsden et al. 1994). With these established procedures, hierarchy distinguishes departments responsible for different functions and shapes members' understanding of who does what, when, and how (e.g., film production organizations in Bechky 2006; emergency department employees in Valentine and Edmondson 2015). A clear hierarchy, enabled by formalized rules and norms, specifies collective expectations of members' roles, expertise, and decision-making capacity (Kwaadsteniet and Dijk 2010).

The evidence of how hierarchy shapes innovation is mixed (for a review, see Damanpour and Aravind 2012). Some organizational characteristics associated with hierarchy are shown to hamper knowledge transfer and experimentation (Bunderson and Reagans 2011, Teece 1996). Yet properly designed forms of hierarchy can positively impact problem-solving efforts (Adler and Borys 1996, Cardinal 2001, Keum and See 2017). Cardinal (2001) finds that formalized roles and procedures are associated with greater numbers of radical innovations (i.e., new drug developments) and reasons that the positive role of hierarchy is due to the nature of scientific work. New drug development necessitates correct and meticulous scientific procedures, and thus, is enhanced by clear structure and prescribed roles. Looking at broader idea generation and selection processes, Keum and See (2017) find that while hierarchy negatively impacts the number of ideas generated, it can aid in the selection phase of innovation. Thus, whether hierarchy serves innovation depends on dimensions such as the type and phase of innovation.

Crowdsourcing opens up the innovation process by increasing transparency, facilitating a quick and informal exchange of ideas, and decentralizing the locus by involving the crowd in search of exceptional opportunities (Guinan et al. 2013, Jeppesen and Lakhani 2010, Majchrzak and Malhotra 2020). We posit that this mechanism, when implemented within an organization, can challenge the existing hierarchical structures, practices, and culture (the shared set of beliefs and expectations among members of the organization) in several ways. Soliciting ideas from all parts of the organization, regardless of one's role, professional expertise, department affiliation, and position, bypasses lines of

reporting relationships and roles. In contrast, hierarchy is built on layers of bureaucracy that information must otherwise travel through ("red tape"), and members may be hesitant to pass on information due to a lack of control and evaluation apprehension (Reitzig and Maciejovsky 2015, Seshadri and Shapira 2003, Simon 1947). Moreover, hierarchically organizing departments allows for clear delineation of specialty and responsibility based on function, but broadcasting a problem statement diminishes these departmental and professional boundaries (Lifshitz-Assaf 2018). For internal crowdsourcing to work in the context of a marked organizational hierarchy, members are required to take initiative to contribute ideas and expertise, beyond their prescribed roles and responsibilities. Participating in crowdsourcing, a peer-based innovation mechanism, may even mean defying the hierarchy. This can create friction if supervisors' support for crowd-based innovation is uncertain.

How might the tension between such a peer-based approach to innovation and hierarchical structures, practices, and culture affect employees' views of and motivations for platform engagement? We hypothesize that such contexts of discord lead employees to question the legitimacy of platform engagement. Legitimacy refers to a social judgment about whether an organizational practice is appropriate, suitable, or deserving given existing norms and contexts (Ashforth and Gibbs 1990, Bitektine et al. 2020, Suchman 1995). It results from a process of normative evaluation, questioning, and justification.

In our qualitative study, we explore how members of an organization that is characterized by a high degree of hierarchy perceive internal crowdsourcing. We establish that legitimacy concerns create important disincentives for engagement with internal crowdsourcing, and shed light on the specific tensions that give rise to these legitimacy concerns. As internal crowdsourcing is a relatively novel phenomenon, we are only beginning to understand what motivates employee engagement with platforms that facilitate it (Erickson et al. 2012, Jung et al. 2018, Malhotra et al. 2020, Malhotra and Majchrzak 2014). To add to the burgeoning body of literature on this topic, we consider how specific organizational context, namely the presence of a marked hierarchy, affects employee perceptions of and motivations for

platform engagement. This analysis is important for understanding the effects of different incentives that organizations can use to increase platform engagement.

Recognition incentives for internal crowdsourcing

Recognition incentives such as corporate award programs belong to the most common forms of nonmonetary incentives used in organizations (Frey 2007, Gubler et al. 2016). They play a particularly prominent role in the knowledge economy, where the complexity of tasks and motivations complicates the use of standard monetary incentives. While monetary incentives can undermine people's intrinsic, prosocial, and image motivations (Frey 1997, Gneezy et al. 2011), social recognition has the potential to bolster them (Frey and Gallus 2017). This is especially important in the context of crowdsourcing, where motivations have been found to be highly multi-faceted and evolving. These motivations include intrinsic enjoyment of problem solving and 'tinkering', being part of a community one identifies with, improving one's career prospects, helping others, learning, and finding solutions to one's own problem (Blohm et al. 2018, Hertel et al. 2003, Hippel 2017, Jeppesen and Frederiksen 2006, Lakhani and Wolf 2005, Leimeister et al. 2009, Lerner and Tirole 2002). Recognition can be designed to reinforce several of these motivations, as it usually draws on three main dimensions (Gallus et al. 2020a): self-signaling (e.g., reinforcing identification as a 'tinkerer' or sense of belonging to a community), social signaling (yielding pro-social or career-related reputational benefits), and tangibility (providing means for learning or problem solving).

Which combination of underlying motivations prevails depends on the given context. This makes it important to gather context-specific information on the views and motivations of present and potential future users of a given platform. At the most basic level, we can expect significant differences based on whether the platform draws on contributors from within or from beyond the organization's boundaries (internal vs. external or "open" crowdsourcing), and whether the platform is premised on competition or on collaboration (contest- vs. community-based platforms) (Blohm et al., 2018, Lakhani 2015). The

combination of existing motivations determines which incentives work, and which ones do not yield their intended effects (Leimeister et al. 2009).

The literature testing causal effects of recognition incentives in the field is still in its beginnings (Frey and Gallus 2017). Recent research suggests that recognition can be highly effective in motivating different forms of peer-based innovation. But to advance towards a more general framework of when and why recognition incentives work, it is important to take into account the existing motivations, and to distinguish between the different forms of recognition. One fundamental difference is the audience involved (Gallus et al. 2020a, Leimeister et al. 2009).

In a field experiment run within the Wikipedia community, Gallus (2017) found that a purely symbolic award scheme backed by senior community members causally increased the retention rate among new contributors by 20% in the month after the award was posted on contributors' personal profile pages. The treatment effect was long-lasting; it continued to be significant for an entire year after the intervention. Being seen and appreciated by senior peers was an important mechanism driving these results. Similarly, appreciation and attention by the community of users more generally (Huberman et al. 2009, Zhang and Zhu 2011), by lower- or equal-status peers (Restivo and Rijt 2012, 2014), or by the platform-hosting firm (Dahlander and Piezunka 2014, Jeppesen and Frederiksen 2006, Leimeister et al. 2009, Piezunka and Dahlander 2019) have been found to be important sources of motivation.

While these studies suggest that recognition and attention by peers and by managers might both have positive effects, few studies were able to study these two fundamentally different forms of recognition in the same field context, i.e., holding everything else constant. Moreover, most of the research has focused on external and/or contest-based crowdsourcing. Since the effects of incentives depend on the underlying motivations of platform participants, we cannot readily assume that similar results obtain for collaboration-based crowdsourcing within organizations.

In the context of internal crowdsourcing, the existing organizational structures, practices, and culture likely play a major role in determining the effectiveness of incentives; these contextual factors reflect and moreover shape participants' expectations and beliefs. This creates a conundrum for

hierarchical organizations that seek to adopt collaborative, peer-based innovation mechanisms within their organizational boundaries. Should they implement recognition incentives that reflect the established hierarchical structures, practices, and culture, or should they use recognition incentives that are in line with the aspirational approach to innovation to signal the intended shift towards peer-based, informal problem identification and problem solving? In hierarchical organizations, it is possible that attention from managers and their judgments triumph. It is also possible, however, that emphasis on peer-based recognition is needed as this signals the intended shift. Moreover, to the extent that workers have concerns about management's negative judgments about engagement with novel practices, an audience of like-minded peers might be preferred over managers' attention.

These questions also speak to the fundamental distinction between different types of recognition incentives based on who is the audience (Gallus et al. 2020a). What are the incentive effects of formal recognition in front of management (which we call 'managerial recognition'), and of informal recognition in front of peers ('peer recognition')? Moreover, as organizations increasingly rely on virtual collaboration tools, including notably online crowdsourcing platforms: Does it matter whether peer recognition is provided in person in front of immediate co-workers (offline peer recognition) or digitally in front of a virtual audience (online peer recognition)? Answering these questions is important for advancing our understanding of when and why recognition works. It also allows us to gain deeper insights into the fundamental motivations underlying internal crowdsourcing within hierarchical organizations.

STUDY SETTING: NASA AND NASA@WORK

NASA@WORK is an inner-organizational, collaborative platform set up for workers to draw from each other's expertise and ideas. This is in contrast to the agency's outward-facing and competitive crowdsourcing programs (Boudreau et al. 2011, Jeppesen and Lakhani 2010, Richard et al. 2019). Anybody working for NASA (civil servants, whom we will refer to as "employees", and contractors) can contribute to NASA@WORK. To engage with the platform, people create a user profile with their real name and center affiliation. All posts are publicly visible and tied to that username. The platform is akin

to an online forum in which users can post questions or problems (i.e., become a "challenge owner"), post answers or solutions (i.e., become a "challenge solver"), respond to other people's submissions, or browse and learn about initiatives and projects across the agency (e.g., Dahlander and Piezunka 2014, Jeppesen and Frederiksen 2006). The challenge owner determines the length of the submission period and selects up to two winners from the pool of contributors. The "challenges" posted on the NASA@WORK platform range from broad questions seeking to initiate collective brainstorming to highly technical and well-defined problems. To illustrate, one challenge owner asked for ideas as her work group sought to expand targets monitored (e.g., analytes, biomarkers, compounds) on the International Space Station during long-duration missions. In a more specific challenge, another challenge owner asked for vendors and technology applications to develop a helmet that could quickly and seamlessly change its tint to protect the astronaut's eyes from solar radiation without having to carry a second visor material. Not all challenges asked for technical or scientific input. For example, one challenge crowdsourced design ideas for a crosswalk at the Johnson Space Center.

When NASA@WORK was first introduced at NASA, winners could receive small monetary prizes, but these had to be discontinued in the wake of the government funding sequestration (NASA 2013). This made the search for non-financial incentives a priority and motivated the research collaboration. We worked closely with the managers of the federal Center of Excellence for Collaborative Innovation (CoECI) at the NASA Johnson Space Center, which manages the platform. The CoECI team was seeking to introduce non-financial incentives and had already identified several options. We further refined and tied these incentives to theory and then worked out an experimental strategy to evaluate their causal effects.

Our sample consisted of 7,455 NASA@WORK users, evenly split among employees (51.2%) and contractors (48.7%). Many of the accounts were dormant. Less than 40% of users had logged in at least once on the platform during the six months before the experiment. From platform inception to the time of our experiment, 48 users, or 0.6% of our sample, had posted and managed a challenge on the platform. 76 users (1.0%) had "solved" a challenge (were chosen as a winner by the challenge owner).

The platform engagement was low overall, for both solution seekers and contributors. We used our field collaboration to develop a deeper understanding of the reasons for this low usage.

QUALITATIVE STUDY

It is important to consider the organizational context when adopting information technology like a crowdsourcing platform (Zammuto et al. 2007). We sought to understand how employees (users and potential users of the platform) perceived and experienced internal crowdsourcing in the presence of a marked organizational hierarchy. While prior research has examined other forms of information technology like emails and knowledge repositories (e.g., Kane and Alavi 2007), the phenomenon of internal crowdsourcing is still new and under-researched (Malhotra et al. 2017).

Data collection

We conducted 53 semi-structured interviews of NASA employees and contractors. Informants were purposively sampled (Berg 2001) from the population of NASA@WORK users (i.e., those with a registered account on the platform). We used attributes such as users' prior activities on the platform (posted a challenge, posted solutions, both, or none), whether s/he was an employee or a contractor, and center affiliation, to obtain a broad range of perspectives. We also used snowball sampling (Berg 2001) to reach those without a registered account on the platform and those with a dormant account (no activity since registration). At the end of each interview, we asked informants for names and contact information of colleagues who might not be familiar with NASA@WORK. We continued our interviews until it appeared that we had reached theoretical saturation, such that additional interviews did not reveal any new information (Glaser and Strauss 1967).

The informant sample comprised 37 employees and 16 contractors. In terms of platform engagement, 6 informants did not have a registered account, 7 had a dormant account, 10 had logged in on NASA@WORK over the past 6 months but had not posted anything, and 30 had logged in over the past 6 months and had made at least one post. More than half (56.6%) of the interview sample had

contributed a post and were therefore familiar with the platform, but none were "prolific" users: none of the informants had posted more than one challenge, and they had solved on average 1.3 challenges (with a maximum of 3 challenges). All interviews were conducted using Zoom, a video conferencing software. The interviews averaged 34 minutes each and ranged from 19 to 54 minutes.

At the beginning of each interview, informants were given a general statement about the purpose of research ("to learn how employees perceive the internal crowdsourcing platform in terms of its purpose, benefit, cost"). Each interview began with a question about the informant's extent of engagement with NASA@WORK. Then, we asked customized open-ended questions depending on whether the informant had made a post on the platform or not. For those who had made a post, our questions sought to understand their motivations for participation, any challenges underlying their participation, and reasons for (not) participating again. For those who had not made a post, we asked about any perceived barriers to platform usage and what might motivate them to use the platform. We asked all informants how they would characterize the purpose of using NASA@WORK, what might motivate more people to use the platform, to what extent one's role (e.g., scientist, engineer, support function) and employment status (employee or contractor) might affect one's platform engagement, and whether and how NASA employees would get compensated or recognized for participating in activities like NASA@WORK.

Analytic approach

We used thematic analysis (Attride-Stirling 2001, Braun and Clarke 2006, Flick 2014) to analyze the interview data. We chose this qualitative analytic approach because it allows a detailed and nuanced account of a particular theme that relates to a specific question (Braun and Clark 2006). In our case, we were interested in exploring a thematic range and illustrating a distribution of views relating to barriers to engaging with the internal crowdsourcing platform at NASA. Thematic analysis entails three classes of themes (Attride-Sterling 2001): (1) empirical themes, which are the most basic or lowest-level order themes derived from data, (2) organizing themes, which group empirical themes into abstract clusters of

similar issues, and (3) global themes, which assemble organizing themes that together reveal interpretation of data as a whole and present an argument, proposition, or assertion about a given issue or reality.

The analytic procedure involved coding and identifying themes through careful reading and re-reading of the data (Rice and Ezzy 1999). We followed the analytic steps outlined in Braun and Clark (2006) and Attride-Sterling (2001). We began with initial coding of the entire data without a preconceived coding frame. Braun and Clark (2006) characterize this phase as coding "interesting features of the data in a systematic fashion". Next, we collated the codes and drew "basic", empirical themes from the coded text segments (Attride-Sterling 2001). This inductive analysis was meant to let the data drive the identification of empirical themes. Table 1 summarizes the progression of coding. Based on this analysis, we constructed a thematic map by arranging empirical themes into organizing themes. We deduced a global theme by iterating between data analysis and theory. We present the qualitative data using labels indicating employment type (employee or contractor), extent of platform engagement (no account, dormant account, browse only, or post and browse), and interview number.

[Insert Table 1 here]

Findings

The interview data brought several important barriers for engagement to the fore. These barriers seemed to be largely rooted in the context of hierarchy, manifesting as established innovation processes that are facilitated by networks based on designated expertise and roles, formalized procedures for core work, and layers of authority. In summary, we find that (1) informants perceived platform engagement as inconsistent with the existing (hierarchical and formal) approach to innovation, (2) they did not consider it a resource for making progress on their 'core' tasks that they had been assigned, and (3) they did not see it as being clearly supported by management. Together, these perceptions led to significant legitimacy concerns about platform engagement. Figure 1 illustrates the structure of our qualitative data.

[Insert Figure 1 here]

Inconsistent with NASA's existing approach to innovation. NASA has centers and facilities spread across the United States. Each houses different areas of knowledge and supports different elements of missions (Seitzen 2008). Our informants shared that clear knowledge boundaries and coordination protocols existed within centers. One said that each location "acts as their own fiefdom" (CP24), and knowledge sharing did not routinely take place across the entire organization. Another informant explained,

> We are so bad about having these silos of knowledge at each center and not utilizing knowledge bases across centers. We end up duplicating work and effort because there's not a good understanding of what knowledge is available to other centers. (CB43)

Even when centers face similar technical problems (despite supporting different aspects of NASA missions), collaborating and reaching out beyond the center for solutions did not seem to be a standard practice and was limited by a dearth of facilitating structures.

In contrast, NASA@WORK introduced a crowdsourcing structure that opened the problem identification and problem solving process to all NASA workers across the agency, regardless of expertise, tenure, role, position, and center affiliation. Informants shared that before NASA@WORK, there had been no other platform that would have enabled communication and collaboration beyond established knowledge networks. The platform introduced a broadened innovation process that was unfamiliar to many. Some even considered it inappropriate as they were accustomed to having clear problem-solving boundaries and protocols. One informant described the platform as "something that is orthogonal to the normal structure of projects and mission directorates" (EP31). Broadcasting a question beyond existing work groups and networks of contacts to seek ideas was not the norm. In fact, some NASA employees and contractors appeared to evaluate NASA@WORK as unfitting given these existing information sharing practices.

Whereas the existing practices promoted innovation that takes place within circles of designated experts, NASA@WORK promoted "finding expertise across the agency", which is "not part of the culture" (EP19). Informants explained that a culture shift would be necessary for the adoption of a broadened, more transparent, and more informal peer-to-peer innovation process such as the one introduced by NASA@WORK. One informant said,

> It's not something that people in the dominant culture here understand. [That culture is] more hierarchical and process-oriented. This [platform] goes against that [culture] because you can ask anybody anything. (EP26)

Not a resource for core tasks. NASA@WORK was viewed as being separate from core work, rather than as a tool that could serve as a resource. NASA scientists and engineers, whose jobs entail solving technical problems, seemed to rely on designated experts and established networks for help when challenging problems surfaced. One informant explained,

> In our field, a lot of our challenges require very detailed knowledge, and we know pretty much everyone who has that knowledge. You already know the experts. You already have people to go to. You don't need to broadcast your search on the platform. (CP3)

As in this quote, several informants expressed beliefs that the specific and technical nature of their work would not be accessible or relevant for the NASA community at large. Instead, informants shared that the "traditional" (CP12) or "natural tendency" (EB37) to problem solving was to reach out to designated experts, often judged by titles and positions. One informant said,

> If I have a complicated intellectual property question, I'm gonna go to the appropriate expert at NASA, which is our patent council. I'm not going to put that out to people who likely know nothing about it and are not qualified nor hired to comment on such a thing. (ED38)

Given this existing practice of knowledge search based on established titles and positions, NASA@WORK did not seem to come to mind as a useful tool for solving problems related to informants' core tasks.

Informants also shared that they were already at maximum capacity with carrying out their assigned tasks, leaving no bandwidth for activities like engaging with NASA@WORK. Being on the platform and contributing solutions was perceived as a "sidebar activity", distinct from the "primary job function", "main project", or "real work". One informant said, "We work beyond 40 hours. Frankly, I don't see how anybody can expect any of us to go on it during our 'free time'. People simply don't have the time or the energy left over" (EN30). Some informants expressed concern that spending time on NASA@WORK would interfere with their official job assignments. One informant said, "All of us have tons of assignments and work that isn't probably related to the NASA@WORK platform. You're expected to do your work and work on the issues and problems that you have" (EP14). Overall, informants expressed skepticism as to whether being on the platform was a productive use of work time.

Not clearly supported by management. Informants emphasized the importance of top-down approval for any novel initiative or project. NASA@WORK was described as "a new mechanism to do work" (EP26) and "not tied to the main line of work" (EB27). One informant explained, "When you want people to take notice and invest and be involved, the fastest way to do that is to have the chain of management's buy-in on that. Approval for it and even advocacy for it" (EP51). Another informant said, "If employees are using it but their boss doesn't understand, you almost want to incentivize the managers to figure out how to use it" (EP26).

However, our data indicates a disconnect between top managers and middle managers and supervisors in terms of their perceived support for workers' platform engagement. One informant shared,

> Our center directors and our engineering director will be like, "We have this platform, it's awesome. Everyone should use it." Then our branch managers are like, "No, do your work. Don't work on other people's problems". (EP14)

Although top managers were seen to approve and support platform engagement, indicated by their decision to organizationally adopt and maintain NASA@WORK, whether mid-level managers and supervisors saw platform engagement as a valuable activity was unclear or even doubtful for workers. Supervisors' support seemed to carry more weight for workers as they more closely oversaw workers'

day-to-day performance and more frequently interacted with them compared to upper-level managers. One informant explained, “Supervisors would have to decide what they think is the most appropriate amount of time for that kind of an activity and whether they think it's a valuable activity” (ED38). These data suggest that there was significant uncertainty about managers’ beliefs and judgments about platform engagement.

To add to this uncertainty, informants shared that the time spent on NASA@WORK, whether posting a challenge and managing the responses or devising a solution and crafting a written response to a challenge, cannot be formally accounted for. For project management purposes, NASA relies on “charge codes” wherein all workers document “every single minute of the day to different job numbers” (CP16) on a timesheet. One informant shared, “We're slaves to charge codes here. People are not supposed to be doing any work that we don't have a specific charge code for” (CP3). Yet, there was no charge code to account for work done on NASA@WORK. Another informant explained, “We essentially don't get paid for it [contributing to NASA@WORK]. We don't charge our time. It has to be something we have to fit into our normal work, put on top of our normal work, or do it on our own time” (EP52). This absence of formal structures (charge codes) that would have officially sanctioned platform engagement seems to have sent further signals putting doubt on management’s positive judgments of platform engagement.

Consequently, informants expressed concerns about managerial approval and even fear of possible reprimand for platform engagement. There seemed to be a sense that platform engagement was not an authorized activity and that it needed to take place discreetly. One informant said, “We're not supposed to be doing those things. It’s one of those things where it’s much easier for accounting-wise if everybody just pretends they don't happen. So if anybody acknowledged it, I don't think it would be in a positive way” (CN40). Another informant shared an anecdote of a supervisor who took disciplinary action against an employee “who he felt was spending way too much time on NASA@WORK” (ED38), thereby discouraging employees’ engagement with the crowdsourcing platform. Thus, according to our data, endorsement for platform engagement from those immediately higher in the hierarchy seemed to be key.

The lack of clear and visible support from supervisors and management seems to have further discouraged workers from using the platform.

Legitimacy concerns about platform engagement. The factors identified above gave rise to and reflect significant concerns about the legitimacy of platform engagement. The legitimacy concerns were rooted in a perception that crowdsourcing (a peer-based, informal, and more transparent approach to innovation) was at odds with existing innovation processes (which were based on a hierarchical, formal, and cloistered approach); that platform engagement was separate from 'core' work; and that it was not clearly sanctioned by management.

Our interpretation of the relationship between these themes is that the clash between the novel crowdsourcing mechanism and the existing hierarchical structures, practices, and culture created doubts about the actual value of NASA@WORK for advancing critical work. When workers looked to management to determine whether the incongruent approach would be accepted and valuable, they encountered conflicting signals: although upper management endorsed platform engagement, no structures had been put in place to officially sanction the time spent on the platform. At the same time, middle managers and supervisors exhibited skepticism (and at times actively discouraged platform engagement). The resulting legitimacy concerns created important disincentives for platform engagement. If the existing organizational context creates such disincentives, then what would make engaging with an internal crowdsourcing platform more legitimate in the eyes of users?

In the field experiment that follows, we tested whether the prospect of being recognized in front of managers or in front of peers for engaging with internal crowdsourcing would increase platform engagement.

FIELD EXPERIMENT

Interventions

The design and implementation of the managerial and peer recognition treatments were informed by data from a survey that the platform managers had conducted on the NASA@WORK platform in 2013. After the 2013 government sequestration, the use of financial incentives to encourage platform participation had to be discontinued (NASA 2013). Subsequently, the Center of Excellence for Collaborative Innovation (CoECI) conducted a survey on the platform to crowdsource alternative incentives ("As Good as Dollars: Incentives for NASA@WORK that Count!"). Fifty individual participants proposed ideas. We received access to this data and used it as a basis for selecting and refining the recognition incentives to be studied in the experiment.

Several submissions pertained to managerial recognition. One suggestion was to have the Center Director send the solver a "brief note" that expresses gratitude, with a copy of the note sent to "their Official in Charge". Another post suggested a lunch meeting with the program manager and the center director as a potential award. The submitter wrote, "I suspect most of the people that 'put it out there' and respond to a NASA@WORK challenge are also the kind of people that would appreciate some face time with their Program and Center management (and we know how limited and valuable their time is)." In line with our theoretical interest, these suggestions were based on the motivational value of managerial attention, as well as a clear, formal acknowledgement of the value of platform engagement in front of management, thus alleviating legitimacy concerns.

Other suggestions drew on rewards to facilitate offline peer recognition, notably through official pins and printable certificates. One submission recommending the use of such small, tangible tokens reasoned that, "Many people participate in sports for trophies, awards, plaques. This is longer lasting than $200.00". In a similar post, another participant who had responded to NASA@WORK challenges in the past wrote, "All I ever hoped for was a certificate of appreciation to put on my cube wall. It doesn't cost anything, and they could be emailed to the Honorable mention participant's NASA email address". These suggestions were in line with our theoretical interest in awards that facilitate informal offline peer

recognition, and served as a template for the design of the offline peer recognition incentive that we tested.

Another category of suggestions was centered around virtual peer recognition through media such as online websites and newsletter spotlights. One participant suggested "recognizing awardees with a challenge synopsis and solution accompanied by their picture on a NASA public website", and commented that "CoECI would be a natural place for this permanent recognition." Another participant proposed using each center's news publication: "On the last page of the Spaceport News are the employee of the month winners. Perhaps you could have a short blurb there as well. All about recognition and the higher the distribution, the better (usually)." These suggestions informed the design of the online peer recognition incentive.

Based on these suggestions and our theoretical interest in studying managerial and peer recognition as incentives, we worked jointly with the CoECI team to design three incentive messages and experimentally test their motivational effects.[1] These messages partly leveraged materials that had already been commissioned by the CoECI managers, such as the official NASA@WORK pin. The messages were sent via email, which was the main channel of communication about the platform.

The three experimental arms were compared to a control group that received a reminder about NASA@WORK. The text for the control group read:

> Greetings, [Name]!
>
> Thanks for being part of the NASA@WORK community. The NASA@WORK ideation platform allows us to draw on the creative minds across the entire Agency to make wonderful things happen! Challenge Owners who identify issues and bring the Challenge process to fruition are crucial since the best solutions can only be as good as the underlying problems they address.

[1] We also randomly assigned a separate group of users to receive a message about how engaging with NASA@WORK contributes to NASA's mission, a message about the effectiveness of NASA@WORK as a problem-solving tool, or a longer message that combined elements of the other messages. We do not report these results as they are outside the scope of this paper, which focuses on recognition incentives. The exclusion of these treatments does not affect the results we present here. More details and results are available upon request.

[*Specific statements pertaining to each treatment were inserted here*.]

Come explore some of our latest Challenges [hyperlink to NASA@WORK]. Or maybe you want to become a Challenge Owner yourself! If this piques your interest, here are 5 simple steps [hyperlinked] to make the most out of Owning your Challenge.

Please don't hesitate to ask if you have any questions. We are happy to have you as part of the NASA@WORK community.

The email was sent and signed by the manager of the NASA Center of Excellence for Collaborative Innovation. Note that the text in the baseline (control) condition provides a conservative benchmark to test the recognition treatments against. Our field partners hoped to motivate as many users as possible to return to the platform. Therefore, even the email sent to the control group was designed to maximize the number of returns to the platform.

Specific statements pertaining to each treatment were not visible without opening the email. Employees in the managerial recognition condition read that their managers would receive "official letters that highlight their leadership and the other skills they demonstrate". The text was accompanied by a photo of a sample letter sent to managers. Employees in the offline peer recognition condition were informed that they would receive a NASA@WORK pin (which the CoECI managers had previously designed and commissioned) and a letter of appreciation from the NASA@WORK team. A photo of the pin and certificate were shown together with this text. In the online peer recognition treatment arm, employees were informed that they would "be inducted in the newly created [hyperlinked] NASA@WORK Wall of Fame and recognized in the NASA@WORK Monthly Bulletin and in our tweets". This was accompanied by a photo of the NASA@WORK Bulletin. Figure A1 in the Appendix shows screenshots of the control and treatment emails.

Experimental design

We used a natural field experiment (Harrison and List 2004) to evaluate the effectiveness of the different recognition incentives. This means that subjects were randomly exposed to different

interventions and their behavior was not affected by an awareness of the research project. From the pool of employees and contractors who had a registered NASA@WORK account, 7,455 users were randomized into one of the three treatment arms or the control group. We used a stratified randomization procedure, blocking on (1) recent platform engagement (whether the user had been active in the six months prior to the randomization) and (2) employment status (employee or contractor).

As specified in the pre-registration (AEARCTR-0002314), we excluded some groups of users before the randomization: "duplicate accounts (the ones with the lower ID# are dropped as lower ID#s indicate older accounts), users with InnoCentive domains [employees of the platform operator who merely test the platform], users who are part of the NASA@WORK/CoECI team (list of those who operate and manage the platform was provided by field partners), users without name fields, users lacking name and center affiliation information, and users who are identified as interns (as these are transitory accounts)."

Analysis and main results

Table A1 in the Appendix presents a randomization check for the observable user characteristics (employment status, past activity, center affiliation). As expected, before the intervention the differences are all negligible in magnitude and not statistically significant.

In line with our field partners' goal, our primary outcome of interest was platform engagement. We used a binary variable indicating whether a user logged into the platform in the week following treatment delivery. The one-week horizon afforded subjects sufficient flexibility in allocating their time across the different days of the week. Results are robust to limiting the analysis to the first day after treatment delivery, as well as to using click-through data as an alternate dependent variable. This dependent variable is a meaningful measure of engagement for several reasons. First, the content populated on the platform at the time of the experiment does not confound the log-in measure. In contrast, postings to the platform depend on there being a challenge for which a given user has the relevant expertise. Second, in online communities, members differ in their interaction patterns, with some

interacting frequently and others reading messages but rarely posting content on their own (Hammond 2000). For intra-organizational platforms, even lurking on the platform without necessarily posting anything is valuable if it promotes organization-specific knowledge acquisition (Wagner and Majchrzak 2006). It also increases the likelihood of discovering potential collaborators and new knowledge networks. Third, NASA's primary interest was to increase the proportion of employees who would return to the platform as a result of the treatments. Platform log-in was considered the most important first step at this early stage of the platform, where there was not much platform activity and hence no network effects to benefit from. Fourth, platform log-in is a good proxy for costly effort, because security protocols mean that logging back in takes time. Online platform firms such as Facebook invest heavily in making logging in as easy as possible because of its importance for subsequent content provision and consumption. However, security protocols within public sector organizations prevent such seamless integration. Thus, logging in requires effort and is a prerequisite for addressing the content contribution and consumption chicken-and-egg problem afflicting platforms at their inception (Kane and Ransbotham 2016). Lastly, the chance of gaming or manipulation of the incentive system affecting our outcome variable is low. Platform log-in indicates users' *intent* to contribute to the platform. It would not pick up on posts that were made merely to receive a given incentive. Moreover, the recognition incentives were not based on pre-specified, quantified performance criteria like number of posts or log-ins that contenders could otherwise try to reach (Gallus and Frey 2016). Users knew that their contributions would be comprehensively evaluated by the CoECI team, who would then, at its discretion, facilitate the dispensing of the recognition incentives (e.g., Deller and Sandino 2020).

Since the baseline level of posting on the platform was extremely low, we limit the quantitative analysis to this extensive margin analysis of who engages with the platform. This lays the ground for future research that can exploit data from more active platforms. We use an intent-to-treat analysis to be conservative and because reliable data on who opened the treatment emails was not available.

We use a conditional logistic regression model with center-level fixed effects to predict platform engagement from the experimental treatments. We add controls for the four strata used in the

experimental design, crossing employment status with whether or not the user had logged in during the six months before the experiment. We also control for the number of challenges the user had previously owned and solved. Standard errors are clustered by center affiliation.

In the week after treatment delivery, 323 users, or about 4.3% of our sample, engaged with the NASA@WORK platform. The rate in the control group (without incentives) was 3.7%. Table 2 shows the number and the percentage of log-ins for each of the four experimental arms. A 4% engagement rate is not surprising given that platform participation is not part of workers' 'core' tasks and activities. It is also consistent with research on internal innovation contests. Blasco et al. (2019) find a 5% participation rate in a health care setting with several additional reminders and a four-week window to participate.

[Insert Table 2 here]

The regression results are reported in Table 3. As can be seen, the managerial recognition incentive had a significant positive effect on subsequent platform engagement. Compared to the baseline condition, the prospect of managerial recognition increased the odds of returning to the platform by about 45% (OR=1.453, RSE=0.194, *p*-value = 0.005), controlling for other factors such as prior platform engagement. The results for the other treatments are statistically insignificant. These findings hold also in the most basic model without any controls. As can be seen, the point estimate of offline peer recognition is comparable to that from managerial recognition, but its standard errors are bigger and so the difference is not statistically significant (OR=1.341, RSE=0.274, *p*-value=0.151). Nevertheless it is an interesting observation that we will explore further below.

[Insert Table 3 here]

Correcting for multiple hypothesis testing using the Bonferroni method does not meaningfully change our results. The *p*-value on the managerial recognition coefficient in the main specification becomes 0.016 when using the Bonferroni method. As a robustness check, we also analyze the data using randomization inference (RI). In lieu of the traditional sampling-based approach, RI is an increasingly

recommended approach for analyzing data from randomized controlled trials (Athey and Imbens 2017, Heß 2017, Young 2019). Our results remain. The *p*-value on the managerial recognition coefficient becomes 0.033 when using RI.

Exploratory analysis of heterogeneities in the response to recognition incentives

The experiment shows that the managerial recognition incentive significantly increased platform engagement compared to the baseline condition. The prospect of being formally recognized in front of management for their contributions gave workers a chance to be seen by management and it seems to have alleviated their concerns around the legitimacy of platform engagement. In contrast, neither offline nor online peer recognition had significant effects on platform engagement. The prospect of offline peer recognition, however, had a similar magnitude of impact on platform engagement as managerial recognition, albeit with larger standard errors.

Interviews conducted following the experiment suggest an important heterogeneity in the response to offline peer recognition: they indicate that the prospect of being recognized by their local peers was indeed motivating for employees in support functions, who were otherwise less visible and of lower perceived status. One administrative staff shared,

> I'm on the bottom of the totem pole. So I get excited. For almost every project you get a pin or a patch or a sticker. We don't normally get that because we're not really associated with any. (CP32)

On the other hand, an engineer employee, whose work visibly contributes to NASA's organizational mission, noted,

> I feel like for most employees, if they see someone wearing a pin that says, "I served a NASA@WORK challenge", if that is your top accomplishment that you want to wear a pin over, that's probably not a good sign. I think people are conscious of that. (EB53)

This contrast between more and less visible workers may explain why our quantitative estimates show greater variance in the response to offline peer recognition as opposed to managerial recognition. Some

employees, namely those in support functions who are otherwise less visible, seem to be highly motivated by the prospect of being seen and recognized by their offline peers. This provides further support for the attention mechanism that explains part of the motivational effects of the recognition incentives observed above. Less visible workers, who otherwise receive less attention, appear to appreciate and be motivated by the prospect of getting their peers' attention.

Organizations often focus their attention on a small proportion of employees who are already visible as they are perceived as central to the organization's mission–at NASA, those are mostly scientists and engineers. Robert Merton famously coined the term Matthew Effect to describe "the accruing of greater increments of recognition … to scientists of considerable repute and the withholding of such recognition from scientists who have not yet made their mark" (Merton 1968: 58). Similarly, at NASA, various awards celebrate innovation, but these prestigious honors are largely only accessible to employees whose job function already puts them into a visible position that is considered 'central' to the mission. Compared to most others, these workers accrue more recognition, both in terms of quantity and importance of the awards. They are therefore likely to respond only to what they consider to be an important form of recognition in the established hierarchical culture. Yet there is a non-trivial proportion of employees who otherwise receive little recognition (at NASA, about 35% of the jobs are in support functions, notably administration, accounting, legal, transportation, information technology, and others; NASA 2019). It appears that these employees are highly motivated even by smaller, more informal forms of recognition that the more focal employees disregard.

This argument about a differential response to recognition by workers who are otherwise more or less visible, who are on top or at the bottom of the "totem pole", can be extended to an analysis of differential effects by employment types: employees versus contractors. Our informants shared that in several centers and contexts, there can be a noticeable status difference between employees and contractors. As one employee explained, "I've worked on projects where they try very hard to keep everybody as a team and trying to not pay attention to the badge [that designates who is and is not an employee]. In general, at least the projects I work on, we try to forget about that and work as a team"

(EP23). Another employee noted, “There are a lot of training courses that are offered. On some of them there are restrictions where contractors can only sit in on them if there's room. Civil servants, I think, have preferential treatment” (EB42). One of the contractor informants shared that, “Usually NASA's pretty inclusive of their contractor staff, but that [distinction]’s always a small little thing in the back of my head” (CN40).

We therefore analyze heterogeneity in the response to the recognition incentives by employment type (contractor or employee). We would expect that, at least directionally, contractors respond even more positively to the recognition incentives than employees. We had stratified the experimental design on employment type as we had planned to test for such heterogeneity. In our analysis, we include an interaction term for employment type and incentive treatment in the main model.

[Insert Table 4 here]

The results in Table 4 suggest that on average, contractors may have indeed been even more strongly motivated by the recognition incentives than employees. Across treatment arms, the coefficients on the interaction terms are positive and thus point into the expected direction, but they do not reach significance. The interaction with managerial recognition is positive and marginally significant (*p*-value = 0.052). While these results should be interpreted with caution, they provide an intriguing basis for future research into the heterogeneities in the response to recognition incentives.

THEORETICAL CONTRIBUTIONS

In this paper, we addressed the following questions: What are the barriers for employees’ engagement with internal crowdsourcing in the context of organizational hierarchy? When and how do recognition incentives overcome those barriers and increase platform engagement? Specifically, what is the potential of managerial and peer recognition in promoting engagement with internal crowdsourcing in the context of marked organizational hierarchy?

By addressing those questions, our paper contributes to two important bodies of literature. First, it adds to the literature on organizational adoption and management of crowdsourcing as an innovation

mechanism (Bayus 2013, Blohm et al. 2018, Dahlander et al. 2019, Guinan et al. 2013, Leimeister et al. 2009, Lifshitz-Assaf 2018)–and internal crowdsourcing in particular (Blasco et al. 2019, Malhotra et al. 2017, 2019). We extend prior research on the challenges that organizations face in increasing engagement with internal crowdsourcing. Prior research has considered perceived support for organizational learning (Jung et al. 2018), frontline workers' agency to innovate (Malhotra et al. 2020), and the role of proactive senior leadership (Erickson et al. 2012). We introduce legitimacy concerns as an important concept. In hierarchical organizations, informal, peer-based crowdsourcing is at odds with existing innovation processes and is not considered by workers as a resource for advancing their core tasks. This creates uncertainty for workers, who look to management for guidance and approval. Absent clear support from all levels of management, however, workers perceive mixed signals. In our context, although top management seemed to approve of and endorse the platform, no official structures had been put in place to officially sanction working on the platform, and workers were moreover concerned about middle-managers' and direct supervisors' lacking support. These factors sowed doubts about the legitimacy of platform engagement, which created important disincentives for workers to engage with crowdsourcing.

We also extend prior work on the motivations to contribute to crowd-based knowledge platforms (Franke et al. 2013, Gallus 2017, Jeppesen and Frederiksen 2006, Lakhani and Wolf 2005, Piezunka and Dahlander 2019). While much of this prior work has focused on incentives to increase motivation, we add to this line of work by beginning our study with an analysis of the disincentives (notably, legitimacy concerns and its sources) that act as restraining forces against engagement (Lewin 1951). We then show that positive incentives can counterbalance these restraining forces.

A second body of literature we contribute to is the research on recognition and its motivational effects in organizations (Gallus and Frey 2016). The research on recognition has long grappled with the difficulty of establishing clear causal effects. We contribute to a recent line of work testing the causal effects of recognition incentives through randomization in the field. We still know fairly little about the effectiveness of recognition incentives in established hierarchical organizations, and about the role of different forms of recognition incentives. One fundamental and vastly under-researched distinction is

between recognition in front of management and recognition in front of peers. This is highly relevant in the context of hierarchical organizations seeking to adopt peer-based innovation, as formal managerial recognition is congruent with the established structure, practices, and culture, while peer recognition is congruent with the aspirational approach to innovation. We exogenously varied the type of recognition incentive and are, to our knowledge, the first to study the effects of both managerial recognition and peer recognition in the same organizational context (i.e., holding all else constant).

Our findings show strong positive effects from managerial recognition incentives. This builds on and extends prior literature that shows that managerial actions provide important cues for employee behaviors (e.g., Detert and Burris, 2007; Liu, Zhu, and Yang, 2010; Tangirala and Ramanujam, 2012). Much of this prior work is based on observational studies that use surveys to capture perceptions and behavior. Using a clean and rigorous experimental procedure in the field, we were able to measure causal effects on actual behavior. We show that the prospect of managerial recognition can causally motivate employees to engage with a new practice. This effect seems to be driven by workers' desire to be seen by management, as well as the knowledge that the value of their platform contributions would be made clear to their managers, thus alleviating legitimacy concerns. We do not find support for the effectiveness of peer recognition, but these results appear to mask an important heterogeneity by job function and form of peer recognition. Workers in support functions, who otherwise receive less attention and rank lower in the status hierarchy, seemed to be highly motivated by the prospect of being seen and recognized by their local peers. Similarly, a heterogeneity analysis of our experimental data by employment type suggests that contractors, who tend to have lower status than employees, may have been even more strongly motivated by the prospect of recognition.

This adds to the literature on recognition by advancing our knowledge of when (under what conditions) and why what kind of recognition works: in hierarchical organizations, formal managerial recognition appears to be highly effective because it promises attention from higher-ups and alleviates legitimacy concerns; under these conditions, informal peer recognition may be motivating, but only for workers who otherwise receive less attention. We thus emphasize the importance of congruence between

recognition incentives and organizational context (structure, processes, and culture). Our results indicate that the incentive that is congruent with the established organizational context may be needed to blaze the trail towards the aspirational approach to innovation. These findings provide fertile ground for future research, such as studies on the interaction between organizational context and incentives (Gallus et al. 2020b).

PRACTICAL IMPLICATIONS

Our study yields several implications for practice. First, our findings inform the design of incentives when seeking to adopt novel, peer-based approaches to innovation. It is important to understand whether and how the prevalent structure, practices, and culture within an organization correspond to the aspirational approach to innovation on crowdsourcing platforms. If there is incongruence due to the presence of a marked organizational hierarchy, organizations may benefit from starting out with incentives that are still in line with the established, hierarchical culture. This means acknowledging and leveraging the important motivational role played by managers, even if that may seem to be at odds with the intended aim of shifting towards 'flatter', peer-based innovation.

In line with our findings, a recent Gallup workplace survey found that employees identified the source of their "most memorable recognition" as that from their direct manager, followed by senior leaders, customers, and peers (Mann and Dvorak 2016). This may be an indication that hierarchy is still a prevalent means of governing organizations. If this is the case, many organizations will benefit from recognition based on their established formal hierarchies (top-down) and they should be weary of rushing the change by changing too many variables (incentives in addition to the approach to innovation) at the same time. That said, it bears emphasizing that defaulting to an exclusive reliance on traditional economic incentives in the form of monetary payments may not be the best approach. Indeed, our two mechanisms highlight the motivational effects of getting attention from management and of clarifying management's judgments of the relevant activities.

Second, our findings hint at the importance of looking beyond "star employees" and designing recognition incentives that are in reach for the average employee. As one interviewee commented, "maybe just the average Joe at NASA would like to be recognized more" (EP22). We found that employees who were otherwise less visible, who considered themselves to be at the lower end of the "totem pole", were highly motivated by the prospect of recognition, even by the smaller, less formal forms of peer recognition that others in more visible functions disregarded or even ridiculed. This suggests that organizations may be wasting resources if most of their incentive programs are focused on workers whose functions already put them into more visible positions, and for whom the marginal effect of an additional token of recognition may be much lower than for workers who otherwise receive little attention for their efforts to contribute.

Finally, our study highlights the application of learning through experimentation in organizations. We leveraged an experimental messaging design that can be deployed quickly and by any organization: we varied the content of emails that were sent to workers and then measured the behavioral impact of those variations. This paper illustrates how internal analytics or data science teams within organizations could learn more about the effectiveness of incentives in motivating engagement with new or existing practices. Central to this effort is cleanly randomizing treatments, retaining a control group (despite the narrative around "A-B testing"), adopting an adequate experimental approach in light of the available sample size (number of participants), and setting up a data collection infrastructure to measure effects on the outcome(s) of interest.

REFERENCES

Adler PS (2001) Market, Hierarchy, and Trust: The Knowledge Economy and the Future of Capitalism. *Organization Science* 12(2):215–234.

Adler PS, Borys B (1996) Two Types of Bureaucracy: Enabling and Coercive. *Administrative Science Quarterly* 41(1):61–89.

Ashforth BE, Gibbs BW (1990) The Double-Edge of Organizational Legitimation. *Organization Science* 1(2):177–194.

Athey S, Imbens GW (2017) Chapter 3 - The Econometrics of Randomized Experiments. *Handbook of Economic Field Experiments*, 73–140.

Attride-Stirling J (2001) Thematic networks: an analytic tool for qualitative research. *Qualitative Research* 1(3):385–405.

Bacharach SB, Bamberger P, Mundell B (1993) Status inconsistency in organizations: From social hierarchy to stress. *Journal of Organizational Behavior* 14(1):21–36.

Bayus BL (2013) Crowdsourcing New Product Ideas over Time: An Analysis of the Dell IdeaStorm Community. *Management Science* 59(1):226–244.

Berg BL (2001) *Qualitative Research Methods for the Social Sciences* (Allyn & Bacon, Boston).

Bitektine A, Hill K, Song F, Vandenberghe C (2020) Organizational Legitimacy, Reputation, and Status: Insights from Micro-Level Measurement. *Academy of Management Discoveries* 6(1):107–136.

Blasco A, Jung OS, Lakhani KR, Menietti M (2019) Incentives for public goods inside organizations: Field experimental evidence. *Journal of Economic Behavior & Organization* 160:214–229.

Blohm I, Zogaj S, Bretschneider U, Leimeister JM (2018) How to Manage Crowdsourcing Platforms Effectively? *California Management Review* 60(2):122–149.

Boudreau KJ, Lacetera N, Lakhani KR (2011) Incentives and Problem Uncertainty in Innovation Contests: An Empirical Analysis. *Management Science* 57(5):843–863.

Braun V, Clarke V (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2):77–101.

Bunderson JS, Reagans RE (2011) Power, Status, and Learning in Organizations. *Organization Science* 22(5):1182–1194.

Cardinal LB (2001) Technological Innovation in the Pharmaceutical Industry: The Use of Organizational Control in Managing Research and Development. *Organization Science* 12(1):19–36.

Chandler AD (1962) *Strategy and Structure: Chapters in the History of the Industrial Enterprise* (MIT Press, Cambridge).

Dahlander L, Jeppesen LB, Piezunka H (2019) How Organizations Manage Crowds: Define, Broadcast, Attract, and Select. Sydow J, Berends H, eds. *Research in the Sociology of Organizations*.

(Emerald Group Publishing, Bingley), 239–270.

Dahlander L, Piezunka H (2014) Open to suggestions: How organizations elicit suggestions through proactive and reactive attention. *Research Policy* 43(5):812–827.

Damanpour F, Aravind D (2012) Organizational structure and innovation revisited: From organic to ambidextrous structure. Mumford M, ed. *Handbook of Organizational Creativity*. *Part D: Organizational Level Influences*. (Elsevier, Oxford), 483–513.

Deller C, Sandino T (2020) Effects of a Tournament Incentive Plan Incorporating Managerial Discretion in a Geographically Dispersed Organization. *Management Science* 66(2):911–931.

Detert JR, Burris ER (2007) Leadership Behavior and Employee Voice: Is the Door Really Open? *Academy of Management Journal* 50(4):869–884.

Donahue AK, O'Leary R (2012) Do Shocks Change Organizations? The Case of NASA. *Journal of Public Administration Research and Theory* 22(3):395–425.

Edmondson AC, McManus SE (2007) Methodological Fit in Management Field Research. *Academy of Management Review* 32(4):1155–1179.

Erickson LB, Trauth EM, Petrick I (2012) Getting Inside Your Employees' Heads: Navigating Barriers to Internal-Crowdsourcing for Product and Service Innovation. *Proceedings of the International Conference on Information Systems*.

Flick U (2014) *An Introduction to Qualitative Research*, 5th ed. (Sage Publications, London).

Franke N, Keinz P, Klausberger K (2013) "Does This Sound Like a Fair Deal?": Antecedents and Consequences of Fairness Expectations in the Individual's Decision to Participate in Firm Innovation. *Organization Science* 24(5): 1495-1516.

Frey BS (1997) *Not Just for the Money: an Economic Theory of Personal Motivation* (Edward Elgar, Brookfield).

Frey BS (2007) Awards as Compensation. *European Management Review* 4(1):6–14.

Frey BS, Gallus J (2017) *Honours versus Money: The Economics of Awards* (Oxford University Press, Oxford).

Galbraith JR (1974) Organization Design: An Information Processing View. *Interfaces* 4(5):28–36.

Galinsky AD, Gruenfeld DH, Magee JC (2003) From Power to Action. *Journal of Personality and Social Psychology* 85(3):453–466.

Galinsky AD, Magee JC, Gruenfeld DH, Whitson JA, Liljenquist KA (2008) Power reduces the press of the situation: Implications for creativity, conformity, and dissonance. *Journal of Personality and Social Psychology* 95(6):1450–1466.

Gallus J (2017) Fostering Public Good Contributions with Symbolic Awards: A Large-Scale Natural Field Experiment at Wikipedia. *Management Science* 63(12):3999–4015.

Gallus J, Campbell S, Gneezy U (2020a) Awards: Tangibility, self-signaling and signaling to others. Unpublished working paper.

Gallus J, Frey BS (2016) Awards: A strategic management perspective. *Strategic Management Journal* 37(8):1699–1714.

Gallus J, Reiff J, Kamenica E, Fiske A (2020b) Relational Incentives Theory. Unpublished working paper.

Glaser BG, Strauss AL (1967) *The Discovery of Grounded Theory* (Aldine Publishing Company, New York).

Gneezy U, Meier S, Rey-Biel P (2011) When and Why Incentives (Don't) Work to Modify Behavior. *Journal of Economic Perspectives* 25(4):191–210.

Gruenfeld DH, Tiedens LZ (2010) Organizational preferences and their consequences. Fiske ST, Gilbert D, Lindzey G, eds. *Handbook of Social Psychology* (Wiley & Sons, Hoboken), 1252–1286.

Gubler T, Larkin I, Pierce L (2016) Motivational Spillovers from Awards: Crowding Out in a Multitasking Environment. *Organization Science* 27(2):233–504.

Guinan E, Boudreau KJ, Lakhani KR (2013) Experiments in Open Innovation at Harvard Medical School. *MIT Sloan Management Review* 54(3):45–52.

Hall JL (2003) Columbia and Challenger: organizational failure at NASA. *Space Policy* 19(4):239–247.

Hammond M (2000) Communication within on-line forums: the opportunities, the constraints and the value of a communicative approach. *Computers & Education* 35(4):251–262.

Harrison GW, List JA (2004) Field Experiments. *Journal of Economic Literature* 42(4):1009–1055.

Hertel G, Niedner S, Herrmann S (2003) Motivation of software developers in Open Source projects: an Internet-based survey of contributors to the Linux kernel. *Research Policy* 32(7):1159–1177.

Heß S (2017) Randomization inference with Stata: A guide and software. *Stata Journal* 17(3):630–651.

Huberman BA, Romero DM, Wu F (2009) Crowdsourcing, attention and productivity. *Journal of Information Science* 35(6):758–765.

Jeppesen L, Frederiksen L (2006) Why Do Users Contribute to Firm-Hosted User Communities? The Case of Computer-Controlled Music Instruments. *Organization Science* 17(1):45–63.

Jeppesen L, Lakhani KR (2010) Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science* 21(5):1016–1033.

Jung OS, Blasco A, Lakhani KR (2018) Innovation contest: Effect of perceived support for learning on participation. *Health Care Management Review*, forthcoming.

Kane GC, Alavi M (2007) Information Technology and Organizational Learning: An Investigation of Exploration and Exploitation Processes. *Organization Science* 18(5):796–812.

Kane GC, Ransbotham S (2016) Content as Community Regulator: The Recursive Relationship Between Consumption and Contribution in Open Collaboration Communities. *Organization Science* 27(5):1258–1274.

Keum DD, See KE (2017) The Influence of Hierarchy on Idea Generation and Selection in the Innovation Process. *Organization Science* 28(4):653–669.

Kwaadsteniet EW de, Dijk E van (2010) Social status as a cue for tacit coordination. *Journal of Experimental Social Psychology* 46(3):515–524.

Lakhani KR (2015) Innovating with the Crowd. Harvard Business School Module Note for Instructors.

Lakhani KR, Wolf RG (2005) Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects. Feller J, Fitzgerald B, Hissam SA, Lakhani KR, eds. *Perspectives on Free and Open Source Software* (MIT Press, Cambridge).

Leimeister J, Huber M, Bretschneider U, Krcmar H (2009) Leveraging Crowdsourcing: Activation-Supporting Components for IT-Based Ideas Competition. *Journal of Management Information Systems* 26(1):197–224.

Lerner J, Tirole J (2002) Some Simple Economics of Open Source. *The Journal of Industrial Economics* 50(2):197–234.

Lewin K (1951) *Field theory in social science; selected theoretical papers* (Harper & Row, New York).

Lifshitz-Assaf H (2018) Dismantling Knowledge Boundaries at NASA: The Critical Role of Professional Identity in Open Innovation. *Administrative Science Quarterly* 63(4):746–782.

Liu W, Zhu R, Yang Y (2010) I warn you because I like you: Voice behavior, employee identifications, and transformational leadership. *The Leadership Quarterly* 21(1):189–202.

Magee JC, Galinsky AD (2008) Social Hierarchy: The Self-Reinforcing Nature of Power and Status. *Academy of Management Annals* 2(1):351–398.

Majchrzak A, Malhotra A (2020) *Unleashing the Crowd: Collaborative Solutions for Wicked Business and Societal Problems* (Palgrave Publications).

Malhotra A, Majchrzak A (2014) Managing crowds in innovation challenges. *California Management Review* 56(4):103–123.

Malhotra A, Majchrzak A, Bonfield W, Myers S (2020) Engaging customer care employees in internal collaborative crowdsourcing: Managing the inherent tensions and associated challenges. *Human Resource Management* 59(2):121–134.

Malhotra A, Majchrzak A, Kesebi L, Looram S (2017) Developing Innovative Solutions Through Internal Crowdsourcing. *MIT Sloan Management Review* 58(4):73–79.

Mann A, Dvorak N (2016) Employee Recognition: Low Cost, High Impact. *Gallup* (June 28) https://www.gallup.com/workplace/236441/employee-recognition-low-cost-high-impact.aspx.

March JG, Simon H (1958) *Organizations* (John Wiley & Sons, New York).

Mintzberg H (1971) Managerial Work: Analysis from Observation. *Management Science* 18(2):B97–B110.

Mintzberg H (1979) *The Structuring of Organizations* (Prentice-Hall, Englewood Cliffs).

NASA (2013) New Policies in Response to Sequestration. Accessed November 5, 2019, https://www.nasa.gov/pdf/736871main_New_Policies_in_Response_to_Sequestration.pdf.

NASA (2019) Workforce Information Cubes for NASA. Accessed November 12, 2019, https://wicn.nssc.nasa.gov.

Nembhard IM, Edmondson AC (2006) Making It Safe: the Effects of Leader Inclusiveness and Professional Status on Psychological Safety and Improvement Efforts in Health Care Teams. *Journal of Organizational Behavior* 27:941–966.

Piezunka H, Dahlander L (2019) Idea Rejected, Tie Formed: Organizations' Feedback on Crowdsourced Ideas. *Academy of Management Journal* 62(2):503-530.

Reitzig M, Maciejovsky B (2015) Corporate hierarchy and vertical information flow inside the firm-a behavioral view. *Strategic Management Journal* 36(13):1979–1999.

Restivo M, Rijt A van de (2012) Experimental Study of Informal Rewards in Peer Production. *PloS One* 7(3):e34358.

Restivo M, Rijt A van de (2014) No praise without effort: experimental evidence on how rewards affect Wikipedia's contributor community. *Information, Communication & Society* 17(4):451–462.

Rice P, Ezzy D (1999) *Qualitative Research Methods: A Health Focus* (Oxford University Press, Melbourne).

Richard EE, Davis JR, Paik JH, Lakhani KR (2019) Sustaining open innovation through a "Center of Excellence." *Strategy & Leadership* 47(3):19–26.

Seitzen F (2008) NASA Facilities. Accessed April 3, 2020, https://www.nasa.gov/50th/50th_magazine/NASAfacilities.html.

Seshadri S, Shapira Z (2003) The flow of ideas and timing of evaluation as determinants of knowledge creation. *Industrial and Corporate Change* 12(5):1099–1124.

Simon HA (1947) *Administrative Behavior: A Study of Decision Making Processes in Administrative Organization* (The Free Press, New York).

Suchman MC (1995) Managing Legitimacy: Strategic and Institutional Approaches. *Academy of Management Review* 20(3):571–610.

Tangirala S, Ramanujam R (2012) Ask and you shall hear (but not always): Examining the relationship between manager consultation and employee voice. *Personnel Psychology* 65(2):251–282.

Teece DJ (1996) Firm organization, industrial structure, and technological innovation. *Journal of Economic Behavior & Organization* 31(2):193–224.

Valentine MA, Edmondson AC (2015) Team Scaffolds: How Mesolevel Structures Enable Role-Based Coordination in Temporary Groups. *Organization Science* 26(2):405–422.

Vaughn D (1996) *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA* (University of Chicago Press, Chicago).

Vaughn D (2006) NASA revisited: Theory, analogy, and public sociology. *American Journal of Sociology* 112(2):353–393.

von Hippel E (2005) *Democratizing Innovation* (MIT Press, Cambridge).

von Hippel E (2017) *Free Innovation* (MIT Press, Cambridge).

Wagner C, Majchrzak A (2006) Enabling Customer-Centricity Using Wikis and the Wiki Way. *Journal of Management Information Systems* 23(3):17–43.

Young A (2019) Channeling Fisher: Randomization Tests and the Statistical Insignificance of Seemingly Significant Experimental Results. *Quarterly Journal of Economics* 134(2):557–598.

Zammuto RF, Griffith TL, Majchrzak A, Dougherty DJ, Faraj S (2007) Information Technology and the Changing Fabric of Organization. *Organization Science* 18(5):749–762.

Zhang XM, Zhu F (2011) Group size and incentives to contribute: A natural experiment at Chinese Wikipedia. *American Economic Review* 101(4):1601–1615.

Zhou YM (2013) Designing for Complexity: Using Divisions and Hierarchy to Manage Complex Tasks. *Organization Science* 24(2):339–355.

TABLES AND FIGURES

APPENDIX

Table 1. Coding Progression of Discrete Data Segments about Platform Engagement

Coded data segment	Empirical theme	Organizing theme
Each center acts as their own fiefdom. (CP24) We are so bad about having these silos of knowledge at each center. (CB43) There's a lot of cases where people in one part of the organization have no idea what another part is doing. (ED17) There's a large base of institutional knowledge. It's hard to access it and hard to understand where to go to access that knowledge base. (CP12)	Knowledge work happens in silos	Inconsistent with existing approach to innovation
NASA@WORK tries to spur cross-pollination, something that's orthogonal to the normal structure of projects and mission directorates. (EP31) With the exception of that [platform], I can't think of another way in which we communicate between the different centers. (CP3) NASA@WORK is an attempt to create a centralized location where people can query the whole knowledge base of NASA. (CP12) It's kind of like people at the bar over a beer and making sketches on a napkin. But taking that into the work setting and having those conversations with people all across NASA, rather than just having the people directly around you at your disposal. (EP23)	NASA@WORK broadens the innovation process	
It's not something that people in the dominant culture here understand. [That culture is] more hierarchical and process-oriented. This [process] goes against that [culture] because you can ask anybody anything. (EP26) It comes down to adapting the culture to the idea of, "we can put out a challenge and get input." NASA centers still have this culture of being cloistered and not interacting with each other. It gets tricky even on an electronic platform to collaborate. There are pockets that do collaborate between the centers, but as a whole, it's not part of the culture to say, "Let's work together and find expertise from across the agency." (EP19) The gatekeepers have been there forever, who technically know most of what's going on. Breaking them out of their world of thinking that they know things will help. (CP24) It's a benefit to break down the not-invented-here mentality to look for ideas from others across the agency. (ED28)	Culture shift is required for adopting the broadened innovation process	
In our field, a lot of our challenges require very detailed knowledge, and we know pretty much everyone who has that knowledge. (CP3) Traditionally that's all been done through knowing somebody. You know somebody who knows somebody who knows something about it. (CP12) Say, I'd like to know how to do X. The natural tendency would be to figure out which organization is responsible for X, and ask them the question or ask them to form a team to get an answer. (EB37)	Reliance on designated experts and established networks	Not a resource for core tasks

I've usually been able to find answers from people here. (EP47) I probably would exercise other options first before doing that. If I have an unsolved issue or am wondering if other departments have input on something, I usually will go directly to the department. (ED41) I know who the subject matter experts are. I don't need a tool to go to a non-subject matter expert community. (ED38)		
We work beyond 40 hours. Frankly, I don't see how anybody can expect any of us to go on [NASA@WORK] during our "free time". (EN30) All of us have tons of assignments and work that isn't probably related to the NASA@WORK platform. (EP14) I lost interest in trying to follow all the challenges, especially with all the other work going on. This is like on the side. Most of the time, NASA employees are already oversubscribed with work. (ED45) I have other responsibilities. It's not going to be a first responsibility to anyone. (EB42) I don't have a lot of time, and I have a ton of work. (CD36)	Core tasks leave no bandwidth for other activities (like NASA@WORK)	
Because it is a new mechanism to do work, you want that encouraged [by managers]. (EP26) If it's not tied to someone's main line work, it really depends on their supervisor. (EB27) When you want people to take notice and invest and be involved, the fastest way to do that is to have the chain of management's buy-in on that. Approval for it and even advocacy for it. (EP51) A lot of it depends on if management is on board with technical teams and encourages them to submit challenges, maybe recognize them for submitting challenges in addition to responding (CP5)	Top-down approval crucial	
Our center directors and our engineering director will be like, "We have this platform, it's awesome. Everyone should use it." Then our branch managers are like, "No, do your work. Don't work on other people's problems." (EP14) I've seen more managerial support from higher levels of management, but not necessarily the direct supervisor. So when you did stuff, like, "wow, you won this crowdsourcing challenge!" that was more beamed about from the top. (EP35) Supervisors would have to decide what they think is the most appropriate amount of time for that kind of an activity. (ED38)	Disconnect between top and middle management	Not clearly supported by management
Contractors have to document every single minute of the day to different job numbers. We have time sheets to enter every day. (CP16) We're slaves to charge codes here. People are not supposed to be doing any work that we don't have a specific charge code for. (CP3) We don't charge our time [spent on NASA@WORK]. (EP52)	Unable to formally account for time on the platform	
We're not supposed to be doing those things. It's one of those things where it's much easier for accounting-wise if everybody just	Fear of possible	

pretends they don't happen. So if anybody acknowledged it, I don't think it would be in a positive way. If I could just have like a couple hours a week to just do my own thing [like contributing to NASA@WORK] without feeling guilty about it at all, that would be awesome. (CN40)	reprimand for use	
During the short period I was involved, I became aware of a situation where a supervisor took disciplinary action against one of their employees who he felt was spending way too much time on NASA@WORK. (ED38)		
There's a perception if you're spending time doing that, then you should have time to be doing real work, too. (EB2)		

Notes. Labels identify whether the informant is an employee (E) or contractor (C); whether the informant has no account (N), a dormant account (D), has an account but browses only (B), or posts and browses on the platform (P); and the interview number.

Table 2. Platform Engagement by Treatment

	N log-in	% log-in	*p*-value
Managerial recognition	98	5.27%	0.014
Peer recognition (offline)	91	4.89%	
Peer recognition (online)	64	3.43%	
Control	70	3.74%	

Notes. The last column shows the *p*-values from a Chi-square test of independence comparing platform engagement across the four experimental arms.

Table 3. Logistic Regression Models Predicting Platform Engagement

	Model 1		Model 2		Model 3	
	Dependent variable = log-in within one week of intervention					
	OR	RSE	OR	RSE	OR	RSE
Treatments						
Managerial recognition	1.433*	0.205	1.440**	0.200	1.453**	0.194
Peer recognition (offline)	1.322	0.266	1.329	0.275	1.341	0.274
Peer recognition (online)	0.915	0.161	0.901	0.157	0.912	0.151
Center-level fixed effects	Not included		Included		Included	
Stratification variables	Not included		Included		Included	
Control variables	Not included		Not included		Included	
Log likelihood	-1,324		-1,257		-1,253	
Observations	7,455		7,386		7,386	

Notes. An odds ratio (OR) less than 1 indicates lower platform engagement than in the control group, which received the baseline email with no treatment; conversely, an OR greater than 1 indicates higher platform engagement than in the control group. Standard errors are clustered by center affiliation. Stratification variables are employment status (employee or contractor) and prior activity (logged in within the 6 months before the experiment). In models 2 and 3, 69 observations are dropped because of all positive or negative outcomes within a center. The main specification (model 3) adds control variables for the numbers of previously owned and solved challenges. Correcting for multiple hypothesis testing using the Bonferroni method does not meaningfully change the results. Using randomization inference (RI) instead of the traditional sampling-based approach does not change the results. The p-value on the managerial recognition coefficient in the main specification becomes 0.016 and 0.033, respectively, when using the Bonferroni method and RI.

*p<0.05; **p<0.01

Table 4. Logistic Regression Testing Heterogeneous Treatment Effect by Employee vs. Contractor Status

	Dependent variable = log-in within one week of intervention	
	OR	RSE
Treatments		
Managerial recognition	1.186	0.205
Peer recognition (offline)	1.152	0.278
Peer recognition (online)	0.735	0.192
Contractor	0.934	0.163
Treatment x Contractor		
Contractor x Managerial recognition	1.492^	0.307
Contractor x Peer recognition (offline)	1.357	0.409
Contractor x Peer recognition (online)	1.526	0.483
Center-level fixed effects	Included	
Control variables	Included	
Log likelihood	-1,253	
Observations	7,386	

Notes. An odds ratio (OR) less than 1 indicates lower platform engagement than in the control group, which received an email but no treatment; conversely, an OR greater than 1 indicates higher platform engagement than in the control group. The regression model includes fixed effects at the center-level. Standard errors are clustered by center affiliation. Control variables include prior activity (logged in within the 6 months before the experiment) and numbers of previously owned and solved challenges. These results remain when we limit our analysis to just employees (n=3,765) or to just contractors (n=3,554). ^p<0.10

Figure 1. Qualitative Data Structure

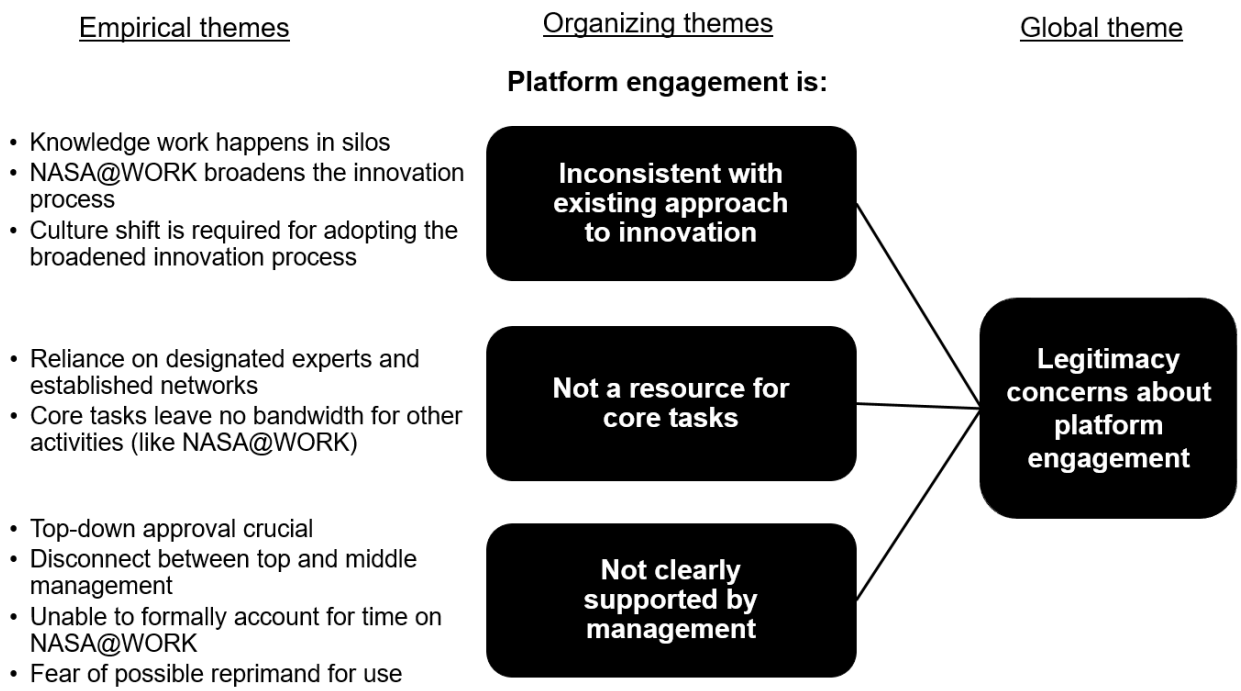

Table A1. Balance Table of User Characteristics by Treatment Assignment (N=7,455)

	Control	Man. R.	Peer R. (offline)	Peer R. (online)	*p*-value
A. Stratification variables					
Employment Status					
Employee (civil servant)	51.0%	51.2%	51.2%	51.5%	0.994
Contractor	49.0%	48.8%	48.8%	48.5%	
Last log-in within 6 months at the time of study	39.6%	39.9%	40.1%	40.1%	0.987
B. Prior activity on NASA@WORK					
Owned a challenge	0.59%	0.54%	0.75%	0.70%	0.840
Won a challenge	1.12%	1.02%	1.13%	0.80%	0.737
Days since last log-in at the time of study	545	581	551	553	0.212
C. Center affiliation					
Armstrong Flight Research Center	1.12%	1.72%	1.43%	1.45%	0.147
Ames Research Center	3.47%	4.14%	3.97%	3.70%	
Dryden Flight Research Center	0.27%	0.27%	0.43%	0.38%	
Glenn Research Center	9.41%	8.34%	7.95%	9.12%	
Goddard Space Flight Center	10.6%	9.10%	8.70%	9.12%	
Headquarters	3.69%	3.66%	3.44%	3.06%	
Independent Verification & Validation	0.48%	0.65%	0.64%	0.38%	
Jet Propulsion Laboratory	3.37%	2.31%	2.36%	2.58%	
Johnson Space Center	28.6%	27.0%	28.2%	28.1%	
Kennedy Space Center	15.2%	14.8%	16.3%	16.0%	
Langley Research Center	7.38%	9.10%	7.20%	7.83%	
Michoud Assembly Facility	0.16%	0.22%	0.48%	0.11%	
Marshall Space Flight Center	11.0%	12.9%	13.8%	12.1%	
NASA Shared Services Center	1.44%	1.94%	1.61%	1.93%	
Stennis Space Center	1.76%	1.56%	2.15%	2.31%	
Wallops Flight Facility	1.39%	1.61%	1.13%	0.97%	
White Sands Complex	0.00%	0.16%	0.05%	0.00%	
White Sands Test Facility	0.69%	0.59%	0.27%	0.86%	
Number of observations	1,871	1,858	1,862	1,864	

Notes. The last column shows the *p*-values from a Chi-square test of independence and analysis of variance (ANOVA) between platform user characteristics and treatment assignments.

Figure A1. Treatment Email Screenshots

Control group

NASA@WORK

Greetings, [name]!

Thanks for being part of the NASA@work community.

The NASA@work ideation platform allows us to draw on the creative minds across the entire Agency to make wonderful things happen! Challenge Owners who identify issues and bring the Challenge process to fruition are crucial since the best solutions can only be as good as the underlying problems they address.

Come explore some of our latest Challenges. Or maybe you want to become a Challenge Owner yourself! If this piques your interest, here are 5 simple steps to make the most out of Owning your Challenge.

Please don't hesitate to ask if you have any questions. We are happy to have you as part of the NASA@work community.

T1: Managerial recognition

NASA@WORK

Greetings, [name]!

Thanks for being part of the NASA@work community.

The NASA@work ideation platform allows us to draw on the creative minds across the entire Agency to make wonderful things happen! Challenge Owners who identify issues and bring the Challenge process to fruition are crucial since the best solutions can only be as good as the underlying problems they address.

This is why we have decided to recognize the Challenge Owners behind our Coolest Challenges. From now on, we will make their managers aware in official letters that highlight their leadership and the other skills they demonstrate.

Come explore some of our latest Challenges. Or maybe you want to become a Challenge Owner yourself! If this piques your interest, here are 5 simple steps to make the most out of Owning your Challenge.

Please don't hesitate to ask if you have any questions. We are happy to have you as part of the NASA@work community.

T2: Peer recognition (offline)

NASA@WORK

Greetings, [name]!

Thanks for being part of the NASA@work community.

The NASA@work ideation platform allows us to draw on the creative minds across the entire Agency to make wonderful things happen! Challenge Owners who identify issues and bring the Challenge process to fruition are crucial since the best solutions can only be as good as the underlying problems they address.

This is why we have decided to recognize the Challenge Owners behind our Coolest Challenges. From now on, they will receive our NASA@work pin together with a personal letter of appreciation from the NASA@work team.

Come explore some of our latest Challenges. Or maybe you want to become a Challenge Owner yourself! If this piques your interest, here are 5 simple steps to make the most out of Owning your Challenge.

Please don't hesitate to ask if you have any questions. We are happy to have you as part of the NASA@work community.

T3: Peer recognition (online)

NASA@WORK

Greetings, [name]!

Thanks for being part of the NASA@work community.

The NASA@work ideation platform allows us to draw on the creative minds across the entire Agency to make wonderful things happen! Challenge Owners who identify issues and bring the Challenge process to fruition are crucial since the best solutions can only be as good as the underlying problems they address.

This is why we have decided to shine a light on the Challenge Owners behind our Coolest Challenges. From now on, they will be inducted in the newly created NASA@work Wall of Fame and recognized in the NASA@work Monthly Bulletin and in our tweets.

Come explore some of our latest Challenges. Or maybe you want to become a Challenge Owner yourself! If this piques your interest, here are 5 simple steps to make the most out of Owning your Challenge.

Please don't hesitate to ask if you have any questions. We are happy to have you as part of the NASA@work community.