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Strategic Innovation at NASA: The Solution Mechanism Guide

By KATHRYN E. KEETON, ELIZABETH E. RICHARD, AND JEFFREY R. DAVIS[*1]

Strategic innovation is vital for future success of business enterprising, including governmental entities. However, to embed strategic innovation within the structural fabric of an organization, sustainable strategic management must support and infuse strategic innovation across the organization. This paper details a strategic management process within NASA that established the pathway for a strategic innovation called the Solution Mechanism Guide (SMG). We propose that the SMG serve as a critical component of a larger theoretical framework in which strategic management successfully embeds strategic innovation and provides a template for other organizations to adopt and tailor to meet their specific needs.

Keywords: Innovation, Knowledge Management, Open Innovation, Crowdsourcing

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I. Introduction

Strategic innovation is a fundamentally different way to compete and sustain success in an existing organization (Charitou and Markides, 2003). Indeed, its importance within organizations is increasing when considering the advancement of technology and the pace of change across industries as organizations continue to seek alternative ways to differentiate themselves from their competition (Berghman, 2012). Researchers have suggested that ambidexterity (defined as an organization's ability to reconcile conflicting demands in terms of resources, organization, and strategic focus that characterize exploitation versus exploration activities) plays a vital role in the success of an organization's ability to strategically utilize innovation internally (Tushman and O'Reilly, 1996; Christensen *et al*. 2002; Berghman, 2012). This also supports Tushman and Anderson's perspective on the importance of congruence between strategic management and strategic innovation approaches within an organization in order to be effective and successful (Tushman and Anderson, 1997).

Considering the concept of 'ambidexterity,' researchers have identified two specific approaches: structural and contextual ambidexterity. Whereas the structural approach builds on Duncan's (1976) argument that organizations need mechanistic structures for efficient exploitation but need organic ones for creative exploration, contextual ambidexterity focuses on the creation of an appropriate "context" (e.g., a stimulating culture) to achieve an exploration–exploitation balance (Berghman, 2012). Current research suggests that the use of an ambidexterity approach may be influenced by the project stage in order for strategic innovation to be successful

[*] Kathryn E. Keeton, corresponding author, CEO and Managing Partner, Minerva Work Solutions Business School, University of Texas. Email: kathryn.keeton@minervawise.com. Elizabeth E. Richard, Founder and Principal, EER Strategies, LLC. Email: elizabeth.richard@eerstrategies.com. Jeffrey R. Davis, Founder and CEO, Exploring 4 Solutions. Email: jeffdavis@exploring4solutions.com.

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(Berghman, 2012). Loose separation is characterized by extensive operational experiments in separate units that link to the broader organization and enable learning and borrowing between core and new businesses (Govindarajan and Trimble, 2004 and 2005).

To exemplify the effective interplay between strategic management and strategic innovation, we share the following case study that describes the successful design, development, and implementation of the Solution Mechanism Guide (SMG). The SMG is a critical knowledge management tool that successfully bridges strategic management and strategic innovation approaches within NASA, empowering employees to utilize innovation tools and platforms, thereby increasing the use of novel problem solving approaches within the organization itself. This case study exemplifies how the SMG further bolsters the ambidexterity of the organization from a loose separation structural approach proposed by Govindarajan and Trimble (2004 and 2005), and demonstrates that in order for strategic innovation to be effectively embedded into the structural fabric of an organization, sustainable strategic management must support and infuse strategic innovation across the organization.

II. The Strategic Management Process: A Case Study

In 2005, NASA's Human Health and Performance (HH&P) Directorate grappled with a 45 percent reduction in its research and technology development (R&TD) budget. The directorate, comprising approximately 1,000 civil servant and contractor scientists, physicians, and engineers, faced the significant challenge of meeting its mission to optimize crewmember health and performance in space exploration with a dramatically reduced R&TD budget. In response, the HH&P leadership formulated a new strategy to build resilience into the organization and buffer future budget changes. This 2007 strategy charted a new course for the HH&P grounded in the pursuit of strategic alliances and other collaborative efforts with external partners to augment internal capabilities and resources, delineating strategic goals and objectives spanning twenty years (Richard *et al*., 2009). Goals focused on driving innovation in human health and performance through collaboration, with an emphasis on solutions that both meet NASA needs and benefit life on earth.

In 2007, the HH&P directorate began a two-year benchmark study with approximately twenty external organizations in academia, industry, and other government organizations to assess how best to identify and manage collaborative relationships. Benchmark results indicated that both the technical and human resources aspects of alliances needed to be managed and that partnerships must be established in order to achieve innovation goals among the organizations interviewed. Implementation of the strategy also resulted in the assessment of open innovation methodologies to provide technical solutions for diverse unmet technical challenges (Richard and Davis, 2007).

In mid-2009, the HH&P initiated four pilot projects in open innovation to pursue technical solutions through internet-based organizations that posted challenges to a diverse and non-traditional group of solvers. Thirty-four challenges (twenty internal to NASA and fourteen external to NASA) were conducted using different vendors acquired through an open competition providing open innovation platforms. Based upon the successful results from its initial pilots in open innovation, the HH&P procured long-term contracts with InnoCentive and yet2.com through an open competition (InnoCentive, 2010). A third platform (TopCoder) was made available when HH&P had an opportunity to participate in a Harvard research project. In addition, at the request of the White House Office of Science and Technology Policy (OSTP), NASA established the Center of Excellence for Collaborative Innovation (CoECI) in November 2011 to provide education and assistance to other federal agencies in running open innovation prize competitions and to develop, collect, and report metrics (Davis *et al*., 2015).

III. Strategic Innovation: The Solution Mechanism Guide (SMG)

Given NASA's proud history of advancing innovations internally or using grant funding and other traditional mechanisms to solve technical problems, the HH&P recognized a need to develop a tool that would utilize both existing and new methods of problem solving to effectively support sustainable strategic innovation and create a culture of collaborative innovation within the directorate. While initial efforts successfully paved the way to increase openness and acceptance of crowdsourcing platforms, a tool that could guide users to an optimal problem solving solution while simultaneously increasing their awareness and understanding of these novel problem solving methods was needed to achieve a culture that embraced collaboration.

To begin this project, a formal needs analysis was conducted to confirm the necessity for this type of tool. Interviews were carried out with individuals representing multiple technical areas of expertise across a range of focus areas including aerospace medicine, biomedical research and environmental sciences, and human systems engineering. Concurrently, a small benchmarking effort was initiated to examine how other organizations have implemented new process models of innovation, what barriers they encountered, what strategies they employed to address these barriers, and how they evaluated the success of utilizing these platforms (data from the initial benchmarking effort described above was also included). Results suggested strong agreement among HH&P technical experts that education, training, and resources (e.g., a prescriptive tool or guide) were needed in order to fully adopt these new methods, supporting initial feedback that was received from early adopters. In conjunction with these voiced needs, results from the benchmarking efforts indicated that improving communication, reducing known barriers, and providing needed support to employees in order to ensure innovative initiatives success were all critical factors to creating an organizational change or shift towards open innovation (Davis *et al.*, 2014). Altogether, these results provided a strong rationale for development of the SMG.

The SMG fully integrates the new resource methods available in collaboration and open innovation with traditional problem solving methods currently used by the HH&P, and provides users a unique hands-on experience so that they may learn and educate themselves about the diverse range of problem solving tools at their disposal. It serves as both a training and resource tool and acts as a catalyst to improve communication across the directorate, providing needed support for technical experts, and reducing known barriers (e.g., management buy-in). The result is to empower SMG users to make more informed decisions, and effectively drive cultural change within the directorate towards embracing open innovation and alternative problem solving methodologies (Davis *et al*., 2014).

IV. Development and Design of the SMG (Alpha Version)

The design and content of the SMG were created with combined input from a small panel of experts who were specifically selected to represent the diverse range of technical expertise, background, and focus areas of the HH&P. Members spanned an array of management levels and technical disciplines within the directorate and consisted of both civil servants and contractors to ensure that a complete perspective was acquired to influence the design and content of the tool. Representatives from NASA's Legal and Procurement Offices were also included on the panel to inform inclusion of specific solution mechanisms. The panel agreed to create this tool in phases to allow for the opportunity to obtain user feedback so that necessary changes could be made based on this input (i.e., fail early and often). Panel members met on a frequent basis to be able to quickly respond to feedback received and to reach consensus on key design and content aspects of the tool. Main functionality and features of the SMG focused on five distinct aspects:

1. **Filtering Mechanism:** users could narrow down possible mechanisms based on their needs/criteria (e.g., the SMG for solution mechanisms (similar to a travel search engine that compares alternative solutions for travel))
2. **Education Portal:** users could enjoy dual-functionality of the SMG, which is both a resource guide and learning tool
3. **Metrics Repository:** metrics for each solution mechanism are captured and tracked historically to determine effectiveness of the SMG over time
4. **Active Updating:** the SMG has a robust administrative capability so content can be easily updated, revised, etc. to ensure the most accurate and effective data is provided and to allow for customization by other groups, departments, centers, etc.
5. **Transfer of Training:** key resources (e.g., point of contact for each mechanism) are provided within the SMG so users can easily get started in implementing a specific solution mechanism by contacting an expert in that particular solution mechanism

The alpha version of the SMG (which included only one filtering question that categorized mechanisms based on the stage of development or maturity of the problem/research focus) was completed in the spring of 2013 followed by a first round of user evaluations. Focus groups were conducted and sixty persons from the HH&P participated. Users were able to try out the tools for themselves using a provided computer. After receiving a short overview, participants navigated the tool on their own. At the end of each session, participants completed an evaluation survey and provided feedback. Results indicated that users liked the overall look and feel of the tool (80 percent), found the tool easy to navigate and use (62 percent), felt that a lot of the information was new to them (58 percent), felt that the tool provided helpful information (74 percent), and thought that they would likely use this tool on the job (62 percent). These results were very encouraging and provided the needed evidence for the HH&P to move forward with developing a complete software tool for users (please see Figures 1-5).

Figure 1: Overall Look and Feel of the SMG

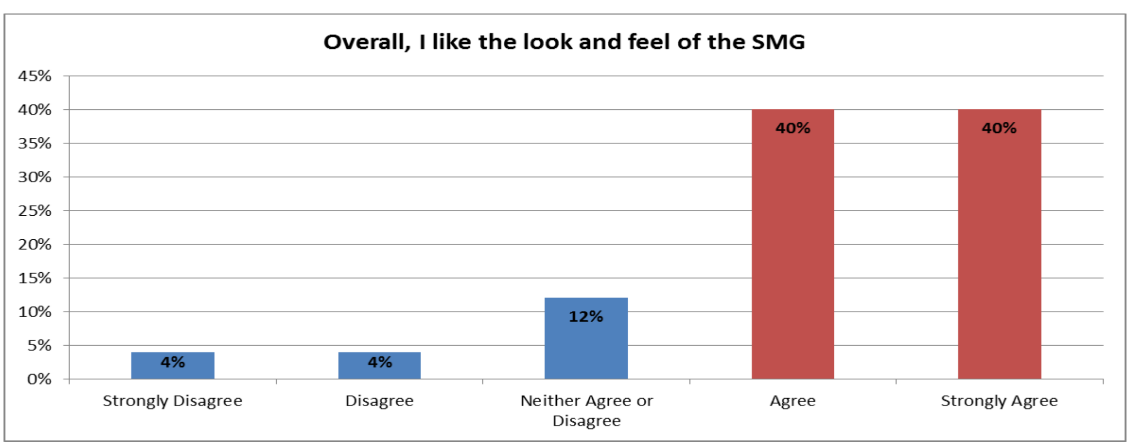


Figure 2: Ease of Use with the SMG

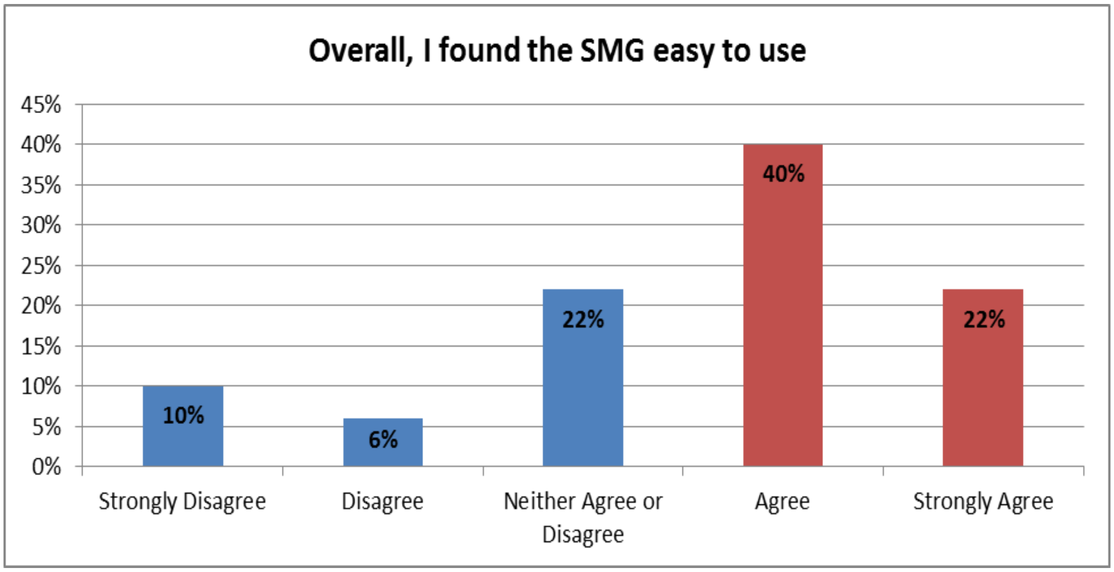


Figure 3: New Information in the SMG

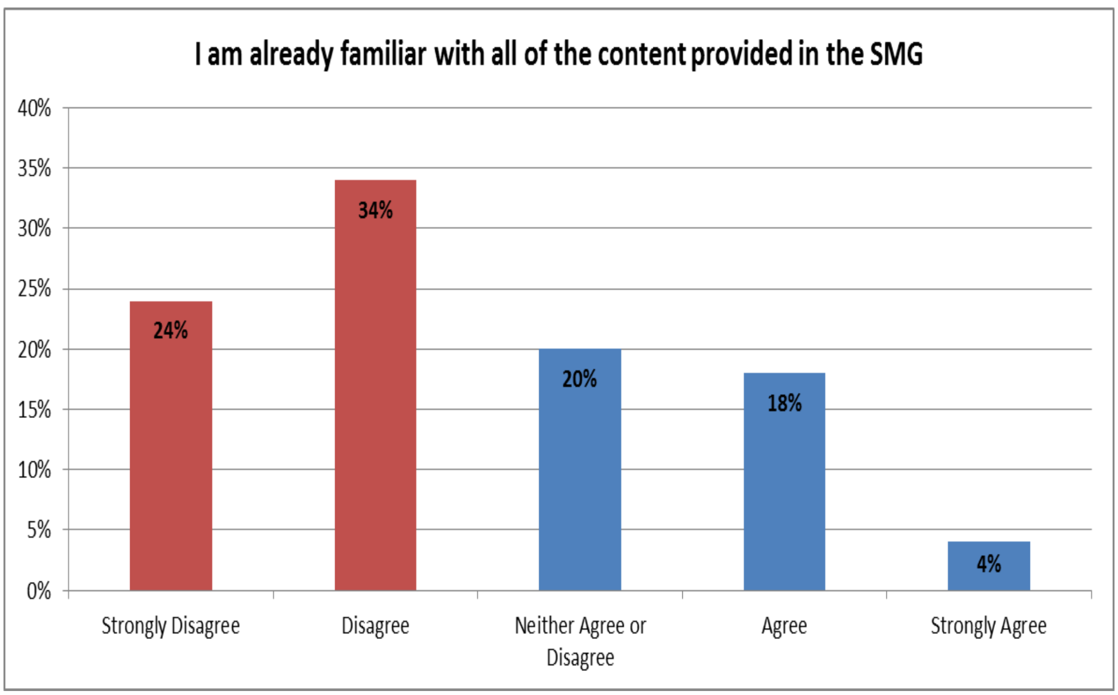


Figure 4: The SMG Provides Helpful Information

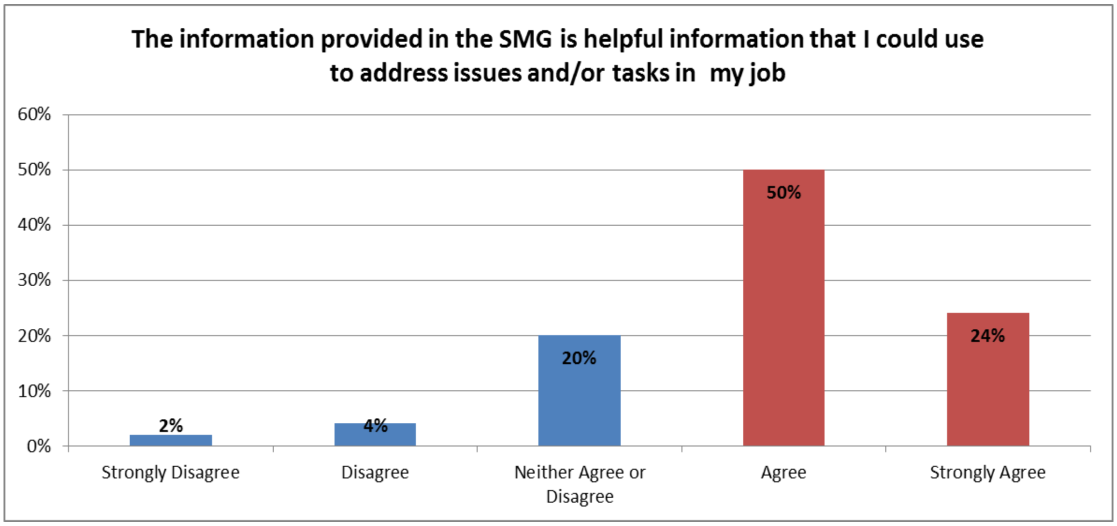
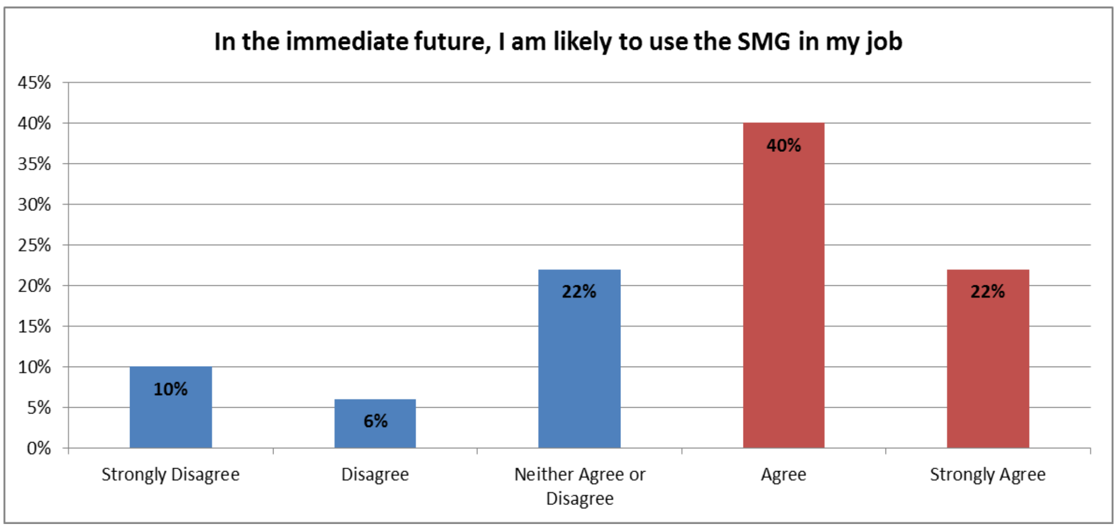


Figure 5: Intentions to Use the SMG



V. Development and Design of the SMG (Beta Version)

Based on the positive feedback that was received from user evaluations of the alpha version of the SMG, funding was secured to develop the beta version of the tool. The beta version of the SMG includes full software functionality with both a filtering feature (the administrator can determine which questions to filter possible mechanisms), as well as a resource/education feature (where new users can learn about the tool and interesting topics related to the tool) and a robust administrative portal, allowing for real-time updates and/or changes to the tool as needed. The SMG also features a "compare" feature that allows the direct comparison of the features of up to four solution mechanisms. Beta development of the SMG began in January 2014 and was completed by July 2014 through a series of development challenges launched from the TopCoder platform (in total, 23 contests were run including 359 registrants from thirteen different countries, with 99 submissions).

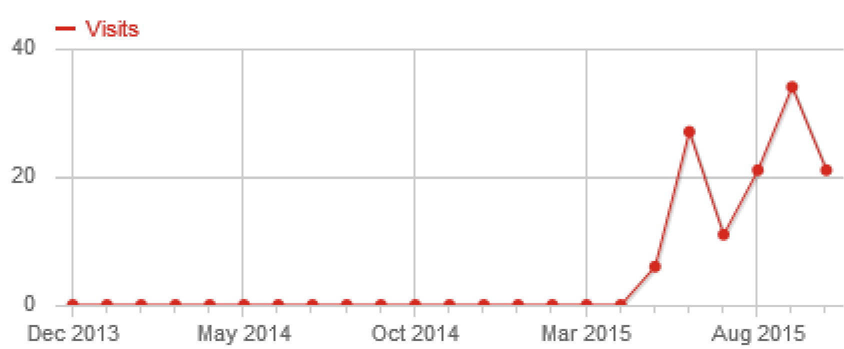
A second evaluation within the HH&P Directorate was completed over the fall and winter of 2014. In total, over 90 individuals participated and provided feedback after rigorous testing of the tool. Whereas the first evaluation was focused more on the utility and usefulness of the concept and the design of the SMG itself, this second evaluation focused more on identifying bugs, issues, and/or problems with the tool that needed to be addressed before full implementation within HH&P. In total, six major bug fix requests were gleaned from this evaluation and were elevated to TopCoder to be fixed. These identified issues were addressed, and the SMG was made ready for launch over the summer of 2015.

VI. Implementation of the Solution Mechanism Guide

The SMG was officially launched within the HH&P Directorate in the fall of 2015. HH&P uses Piwik, an open source website tracking application, to provide data on the number of users that visit the SMG site and its different pages. In addition, the SMG contents itself contains a characteristic that captures the number of a specific mechanism currently in place (e.g., six Space Act Agreements, ten grants, etc.). This data serves as a baseline for each mechanism, and these numbers can be updated and tracked over time to inform how usage of mechanisms may change due to the use of the SMG (i.e., essentially providing an 'effectiveness' indicator of the SMG).

The SMG was officially launched in July 2015 within HH&P at a formal directorate-wide employee event. Since this official launch, the SMG has received a growing number of hits to the site, and early traffic (pre-marketing) numbers are showing promise and growth.

Figure 6: Piwik Analytic Data: Hit Sites to the SMG Website



Since summer 2015, one-on-one evaluations have been conducted within the HH&P Directorate for an emerging leadership team at NASA Headquarters, and by the Strategic Partnerships Office at the NASA Johnson Space Center. Overwhelming positive feedback has been received (and captured from a feedback survey that was administered) from all of these evaluation efforts. Out of the surveys completed, the majority of participants agreed that the SMG provided information not previously known, and would be useful on the job; they anticipated using the SMG if given access (these findings concur with previous results from the first phase evaluation effort described above).

The one-on-one evaluations within the HH&P targeted the diverse areas that comprise this directorate, and participants represented these areas including operations, hardware, research, and medicine. These participants provided real scenarios/problems from their work areas to assess how the SMG might inform project management decisions. Participants were able to review how the SMG would provide insight into available mechanisms given the specific criteria of their problem/issue, and at the same time these users were able to provide real-time feedback to the developers about possible improvements and/or comments for consideration.

VII. The HH&P Strategic Innovation Framework

In her 2012 empirical study, Berghman discusses various structural designs for strategic innovation in the literature, comparing separation and integration designs with structural and contextual ambidexterity strategies. The appropriate ambidexterity approach may differ both by innovation type and by the phase of the innovation project. Smith *et al*. (2008) concluded that organizational structure is a critical factor in innovation management, and that organizational culture is a key factor that impacts all other factors and is impacted by the others, continuously developing and evolving during the strategic innovation process.

The structural ambidexterity strategy follows the classical organizational design argument that efficiency and effectiveness goals each require different structures (Burns and Stalker, 1961). It builds on Duncan's (1976) argument that organizations need mechanistic structures for efficient exploitation but organic ones for creative exploration. This view is further advanced by Tushman and Anderson (1997). Due to this irreconcilability, the structural ambidexterity approach proposes to physically separate exploration from exploitation activities in an organization. More recently, Govindarajan and Trimble (2005) advanced a loose separation strategy, where the separate innovation unit maintains strong links to the core organization. Even though the new organization may be geographically isolated from the established business, operational links enable the innovation unit to borrow core assets. According to Govindarajan and Trimble (2005), the "dual-purpose organization" possesses the ideal characteristics for strategic innovation.

The HH&P designed, developed, and implemented the SMG using a strategic innovation strategy that is best described by Govindarajan and Trimble's (2005) loose separation structural ambidexterity strategy. The concept for this knowledge management tool was grounded on the need to create a culture of collaborative innovation in an organization that historically innovated internally or via collaborations with known institutions using traditional grant funding mechanisms. We posit that this congruence between the strategic management and strategic innovation within this project strongly influenced its success (both past and present).

The directorate established a Strategic Planning and Execution (SP&E) group separate from the technical organizations responsible for advancing technology innovations within the HH&P. This new innovation unit advanced the concept and managed the development of the SMG tool, but developed the tool by working closely with the core technical divisions and support organizations through all stages of developing and testing. The collaborative effort enabled an iterative process that involved the end users from the earliest phase of development through testing to encourage adoption and diffusion of the innovation across the technical organization. This innovation strategy is best described as "disruptive" by Pisano (2015), who defines it as one that requires an organization to change its business model, but uses existing technical competencies to innovate. Establishing the SP&E group exemplified the new business model, while the SMG was developed by a collaborative effort that relied on existing technical competencies.

VIII. Conclusions

This paper highlights a case study of strategic and sustainable innovation, tracks the chronological development of the SMG, and demonstrates its congruence with a loose separation, structural ambidexterity approach. To successfully implement and utilize crowdsourcing, and thereby create a culture of collaborative innovation, NASA needed to increase awareness about crowdsourcing platforms and about which are best for a particular problem, providing a tool that empowers employees to select the mechanism that best fits their particular project needs. The SMG addresses all of these requirements, exemplifying strategic innovation in support of the strategic management process grounded in the strategy for the HH&P Directorate. Establishment of a separate innovation unit, the SP&E group, facilitated the success of this effort by working closely with the core technical groups of the directorate.

This strategic management process outlines a successful path of development for tools needed to promote the use of crowdsourcing mechanisms. Our approach encouraged a fairly rapid development process, facilitating multiple fine-tuning opportunities of needs and requirements and ensuring that the final product was a true representation of the needs presented by our users. It incorporated feedback from the technical core group at critical touch points along the development path, promoting buy-in and increased awareness of the benefits the tool offered. Once implemented, tracking the usage of the SMG via Piwik Analytics allows for an objective evaluation of its effectiveness over time.

In sum, the HH&P used Govindarajan and Trimble's (2005) structural, loose separate ambidextrous organizational strategy for the systematic creation of the SMG. It is also aligned with Pisano's (2015) disruptive innovation strategy. The tool enables new organizational capabilities by adopting a new business model while relying on existing technical capabilities to develop it, advances sustainable innovation across the organization, and promotes a culture of collaborative innovation. We hope this approach inspires other organizations to find their own pragmatic approach in using strategic management to successfully drive strategic innovation.

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